



IME Process Design Kit for Mentor Graphics Pyxis

User Guide

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1. Introduction

1.1. General

This user guide provides instructions for installing and configuring the Institute of Microelectronics (IME) Process Design Kit (PDK) for the Mentor Graphics Pyxis software on the Linux operating system.

This guide is meant to be followed sequentially because each task builds on the previous one.

Note: Linux is a **case-sensitive** operating system. Every instruction in this guide is **case-sensitive**.

The guide describes these tasks:

- Installation
- Project Manager Operation
- Layout Operation
- Running a Design Rule Check
- Exporting/Importing GDS Files
- Fracturing

1.2. Support and Reference Resources

If you need any support for setting up the license, you can submit your request through the CMC technical support website at <http://www.cmc.ca/Help/EngSupport.aspx>.

For more general setup and design issues, you can post a question on the community webpages at <http://community.cmc.ca>.

2. Installation

You can install the files to either the default directory (that is, `$HOME`) or to a different directory (for example, `$HOME/MyDirectory`).

- Installing the Files to the Default Directory
- Installing the Files to a Different Directory

2.1. Installing the Files to the Default Directory

To install the PDK from the compressed files to the default directory (that is, `$HOME`):

1. Navigate to your home directory.
2. To decompress the files, enter the command
`unzip SiEPIC_IME_PDK*.zip -d $HOME/`

The files are extracted to the location `$HOME/SiEPIC_IME`

Proceed to the next section, Project Manager Operation, on page 9.

2.2. Installing the Files to a Different Directory

To install the PDK from the compressed files to a different directory (for example, `$HOME/MyDirectory`):

1. Navigate to the different directory.
2. To decompress the files, enter the command
`unzip SiEPIC_IME_PDK*.zip -d $HOME/MyDirectory`
3. Using the file manager, navigate to `$HOME/MyDirectory/SiEPIC_IME/SiEPIC_IME_PDK`

4. Edit the run script by doing the following:
 - a. Open the script file by right-clicking on the **open_SiEPIC_IME** file icon and selecting **Open** (see Figure 1).

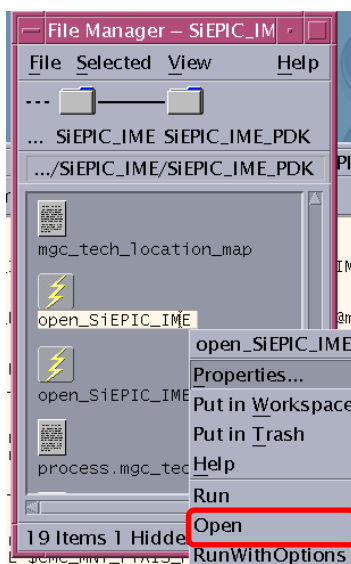


Figure 1: Opening the Script File

The script file opens in the text editor (see Figure 2).

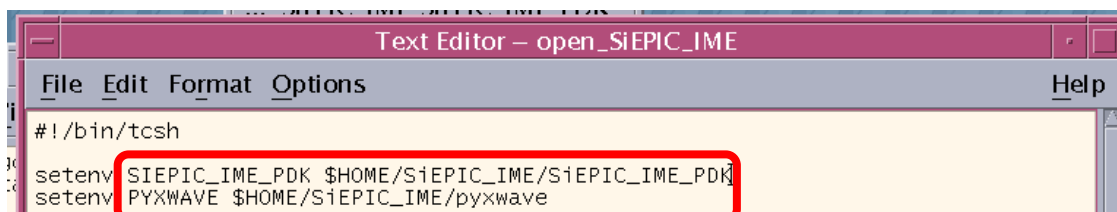


Figure 2: Script File in Text Editor

- b. In the script file, edit the two paths (see highlighted items shown in Figure 2) to reflect the new chosen path.

Note: For the **\$HOME/MyDirectory** example, change the two paths to:

setenv SiEPIC_IME_PDK \$HOME/MyDirectory/SiEPIC_IME/SiEPIC_IME_PDK

setenv PYXWAVE \$HOME/MyDirectory/SiEPIC_IME/pyxwave

- c. Save the file and close the text editor.

3. Project Manager Operation

There are various Project Manager operations:

- Starting the Program
- Creating a New Project
- Creating a New Layout
- Setting Up the New Layout

3.1. Starting the Program

To start Pyxis Project Manager:

1. Navigate to the extracted directory using one of these commands depending on where you installed the files:
 - For the default location, use `cd SiEPIC_IME/SiEPIC_IME_PDK`
 - For a different location, use `cd MyDirectory/SiEPIC_IME/SiEPIC_IME_PDK`
2. Run the script `open_SiEPIC_IME` using the command `./open_SiEPIC_IME`

Pyxis Project Manager opens.

Note: If another project was previously opened, it will appear in the manager. To close the previously opened project, right-click it and select **Close Hierarchy**.

3.2. Creating a New Project

To create a new project:

1. On the toolbar, click the icon **New Project**.

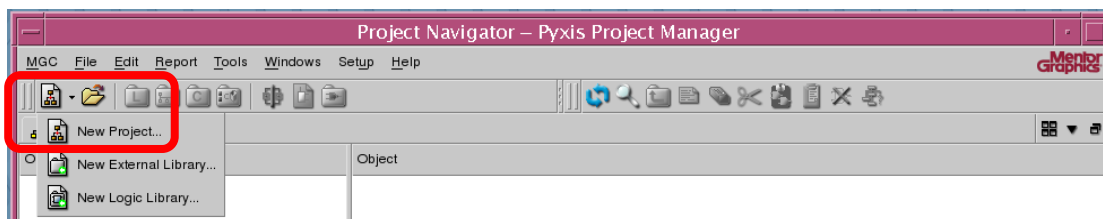


Figure 3: Creating a New Project

The **New Project** dialog box displays the default project path.

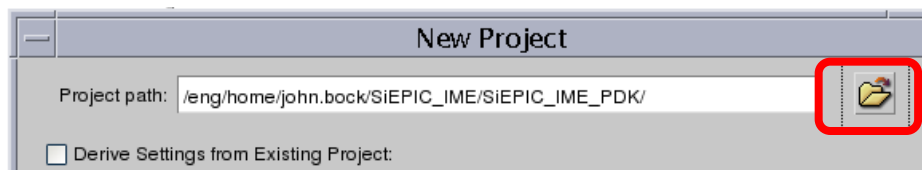


Figure 4: New Project Dialog Box

2. Change the project path because the default path will not be accepted by Pyxis.
 - a. In the **New Project** dialog box, click the icon **Open Directory** to the right of the field **Project path** (see Figure 4).

The **Project Navigator** dialog box displays.

- b. In **Project Navigator**, navigate to the directory where you wish to store your projects.
 - c. Create a new directory for your project (for example, **MyProject**) then select it (see Figure 5).

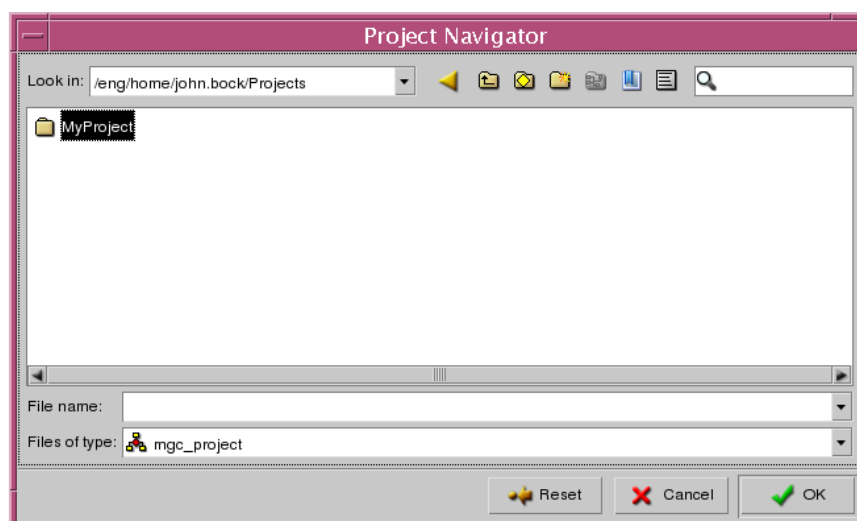


Figure 5: Project Navigator Dialog Box

- d. Click **OK**.

The **New Project** dialog box displays the new path.

3. To identify the location of the technology library, do the following:
 - a. In the **New Project** dialog box, click the **Open Directory** icon to the right of the field **Technology Library** (see Figure 6).

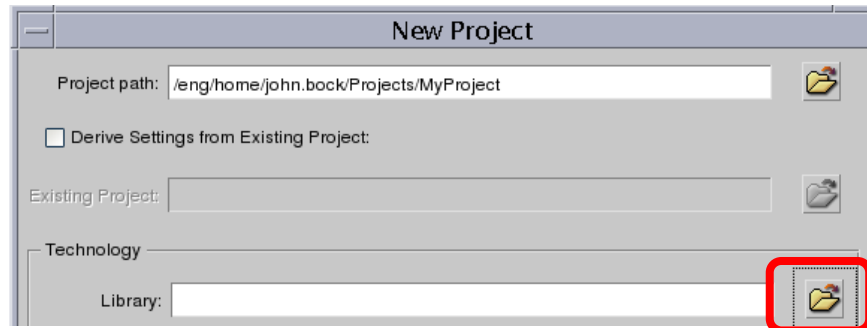


Figure 6: New Project Dialog Box

The **Technology Library Navigator** dialog box displays.

- b. In **Technology Library Navigator**, navigate to the PDK directory `/SiEPIC_IME` then select `SiEPIC_IME_PDK` (see Figure 7).

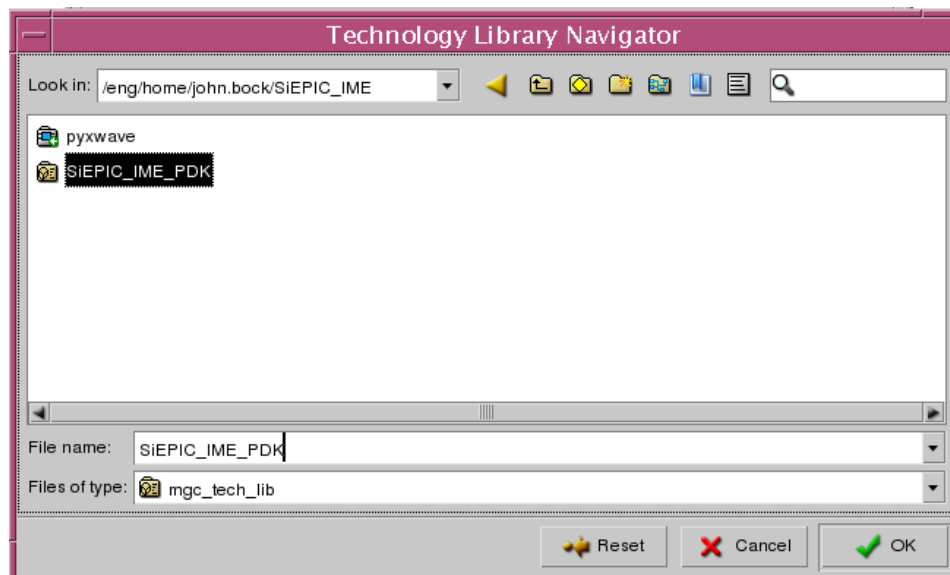


Figure 7: Technology Library Navigator Dialog Box

- c. Click **OK**.

The **New Project** dialog box displays the configuration settings (see Figure 8).

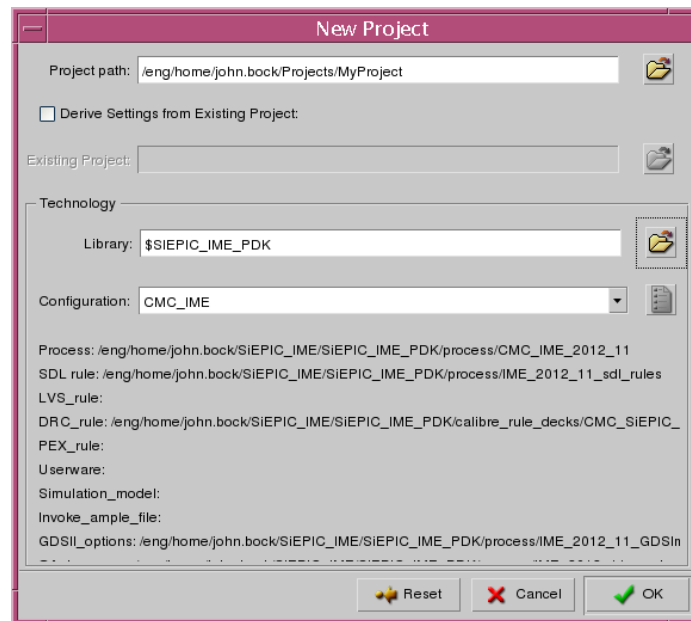


Figure 8: New Project Configuration Settings

4. Click **OK**.

The **Manage External/Logic Libraries** dialog box displays.

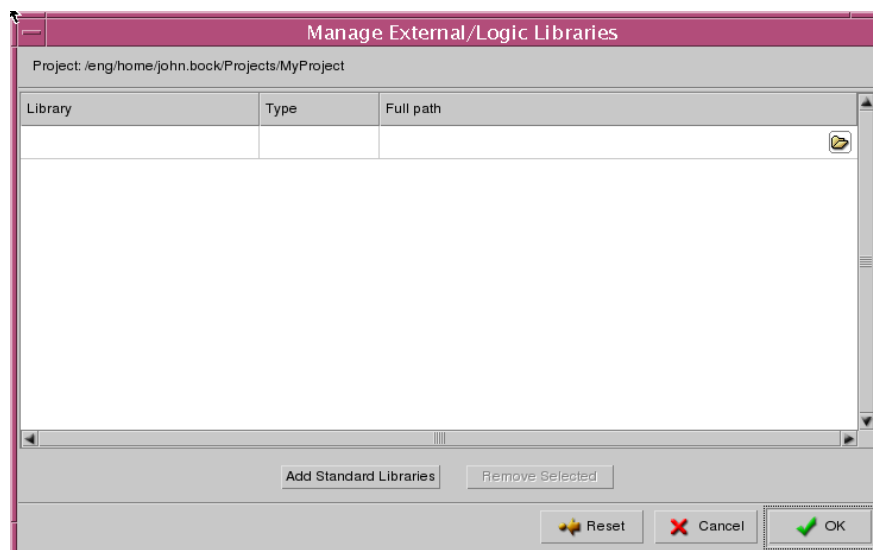


Figure 9: Manage External/Logic Libraries Dialog Box

5. Click **Cancel**.

3.3. Creating a New Layout

To create a new layout:

1. In the left pane, expand **SIEPIC_IME_PDK**.

The **Pyxis Project Manager** displays the component folders of the PDK (for example, **Documentation**, **calibre_rule_decks**, **cell_library** as shown in Figure 10).

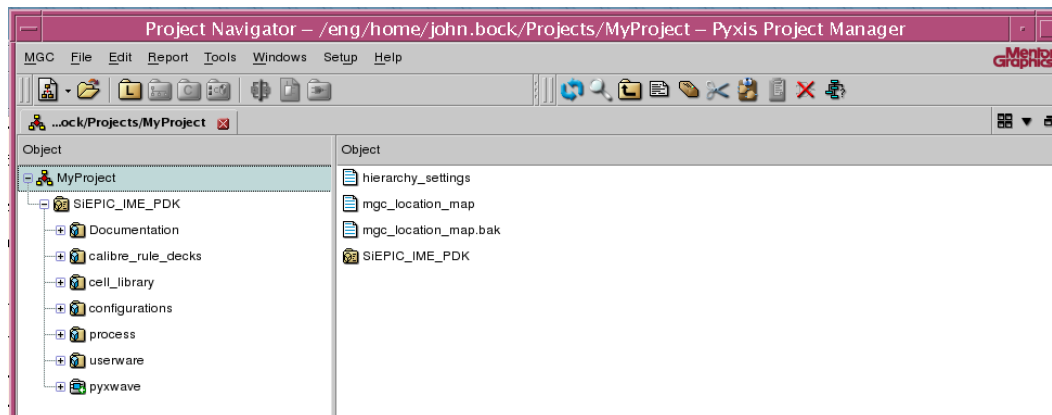


Figure 10: Pyxis Project Manager Component Objects

2. On the toolbar, click the icon **New Library** (see Figure 11).

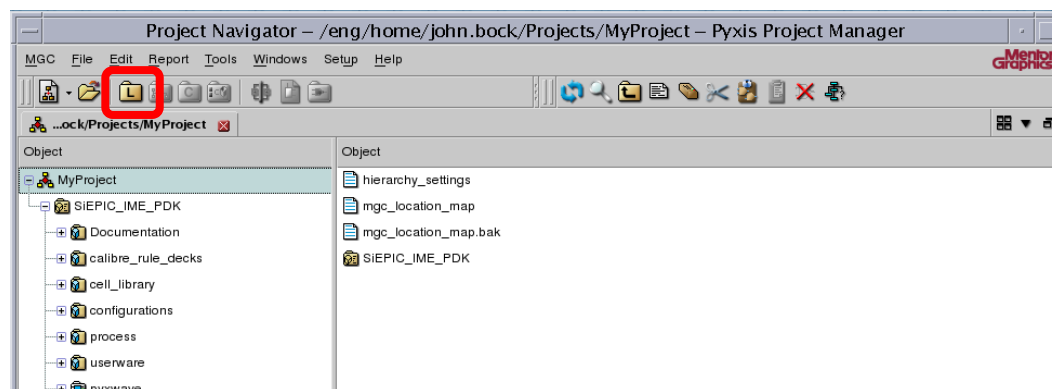


Figure 11: Creating a New Library

The **New Library** dialog box displays.

3. In the field **Library name**, enter **MyLibrary** then click **OK** (see Figure 12).

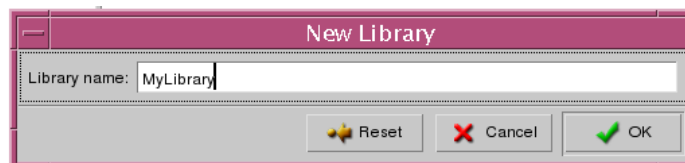


Figure 12: New Library Dialog Box

The new library appears in the left pane under **MyProject**.

Note: The new library is identified with a different icon than **SiEPIC_IME_PDK** because the new library (**MyLibrary**) is a user-defined library whereas **SiEPIC_IME_PDK** is a protected technology library (the PDK). The two different scopes are shown in Figure 13.

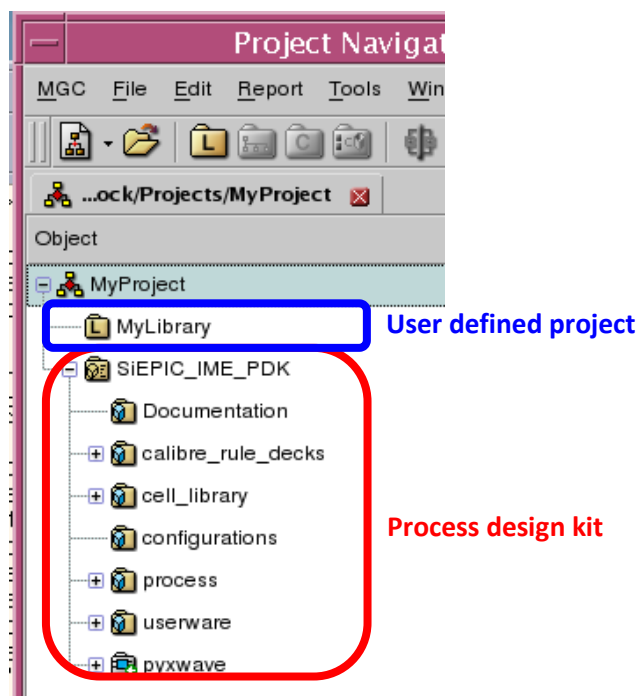


Figure 13: Different Library Scopes

4. In the left pane, select **MyLibrary** then, on the toolbar, click the icon **New Cell** (see Figure 14).

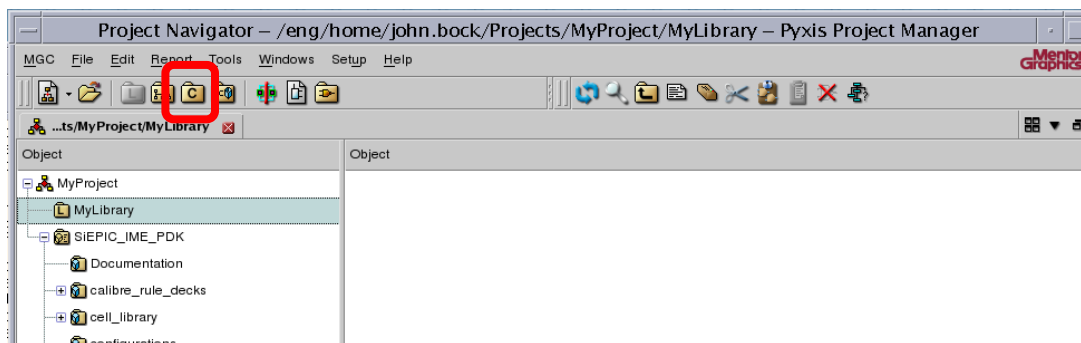


Figure 14: Creating a New Cell

The **New Cell** dialog box appears.

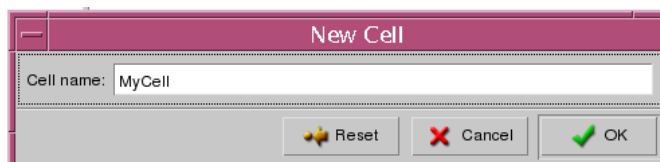


Figure 15: New Cell Dialog Box

5. In the field **Cell name**, enter **MyCell** then click **OK**.
6. In the left pane, select **MyCell** then, on the toolbar, click the icon **New Layout** (see Figure 16).

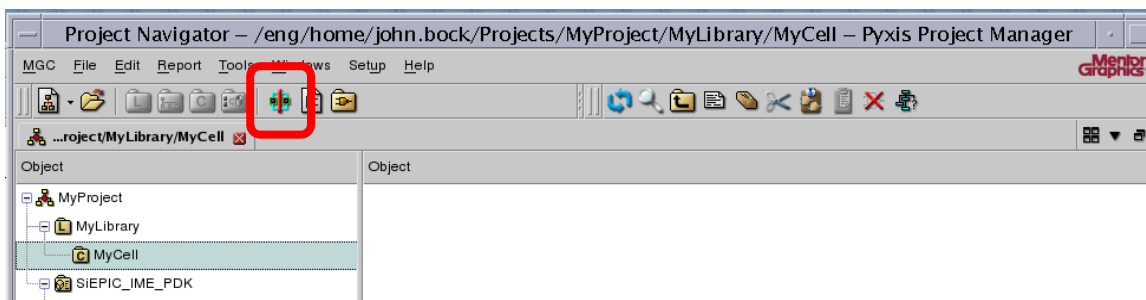


Figure 16: Creating a New Layout

The **New Layout** dialog box displays (see Figure 17).

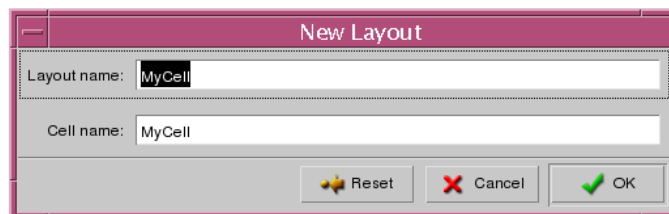


Figure 17: New Layout Dialog Box

The field **Cell name** indicates the location of the new layout.

Note: If the cell name is changed to a name that does not exist, Pyxis Project Manager will create the new cell automatically (selecting **MyCell** first simply populated this field with the selected cell name).

Important: It is fine to name the layout exactly as the cell name (equivalent to naming a file the same as its parent directory). Note that `Projects`, `Libraries` and `Cells` are directories in the actual file system. The file structure for this project is [MyProject/MyLibrary/MyCell/<<layout_name>>](#).

7. For this example, in the field **Layout name** enter **MyCell** then click **OK**.

The **Pyxis Layout** window displays along with the **New Layout** dialog box that is populated with the location of the current cell name, the process path, and the schematic-driven layout instructions (see Figure 18).

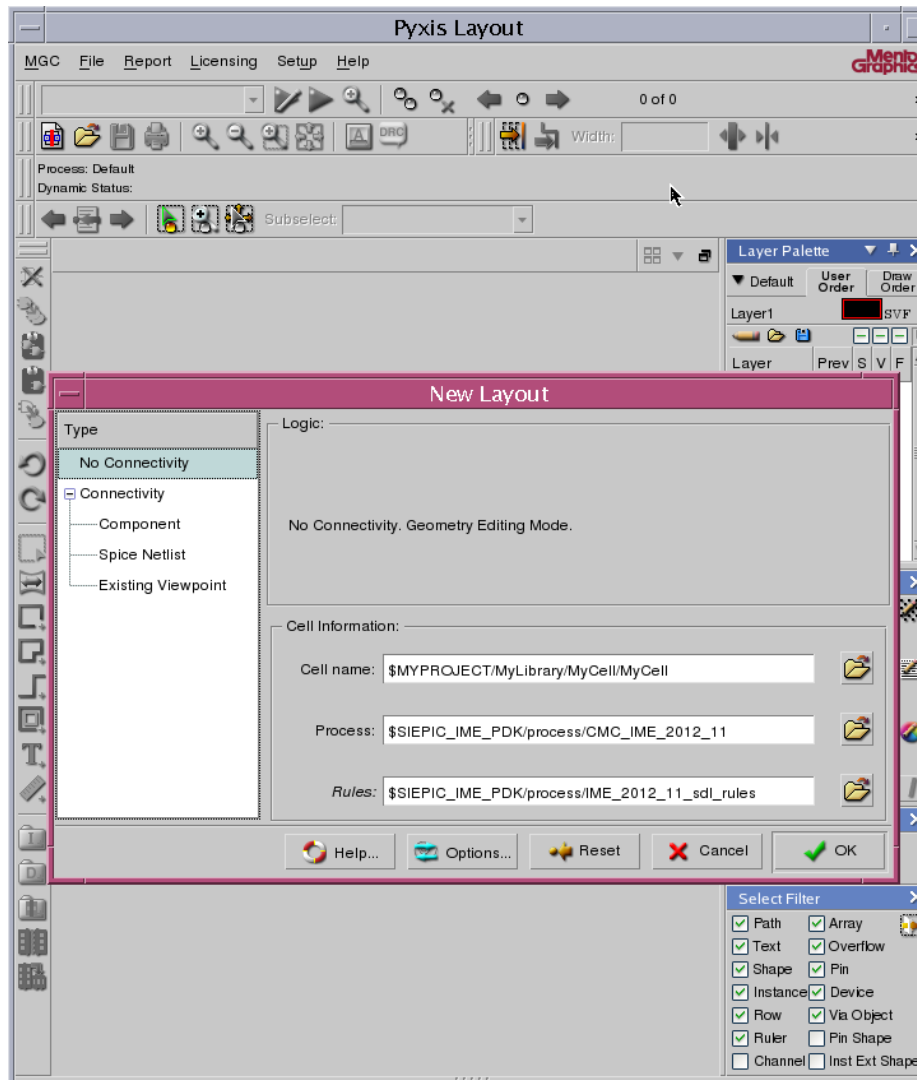


Figure 18: New Layout Configuration Settings

8. In the **New Layout** dialog box, click **OK**.

A new layout appears.

3.4. Setting Up the New Layout

To set up the new Pyxis layout:

1. To show the transcript area, on the main menu select **Setup | Windows | Transcript Area** (see Figure 19).

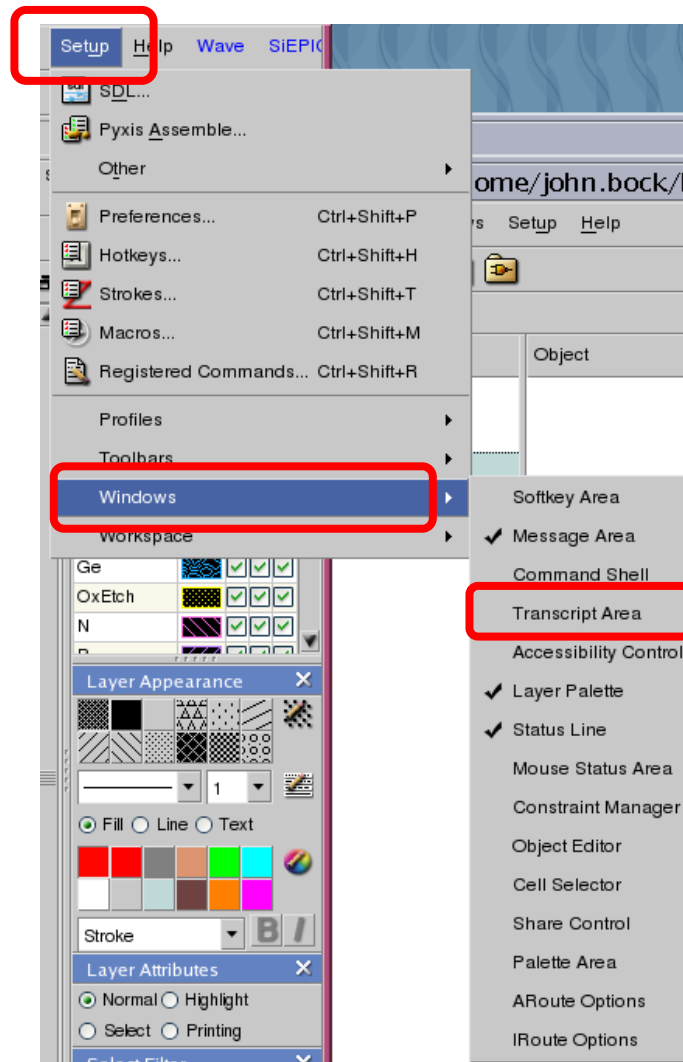


Figure 19: Selecting Transcript Area

- To set up compatibility editing, on the main menu select **Wave | Setup Compatibility Editing** (see Figure 20).

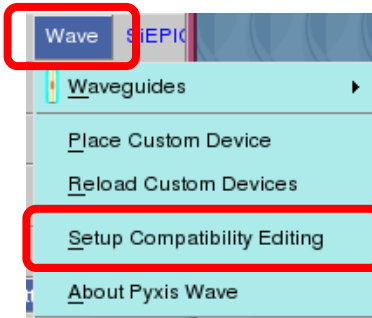


Figure 20: Setting up Compatibility Editing

Note: This setting ensures Cadence-like editing behavior.

The annotations in Figure 21 describe the different components of the PDK as well as showing the added **MyLibrary** containing **MyCell** and **InstanceExample** cells.

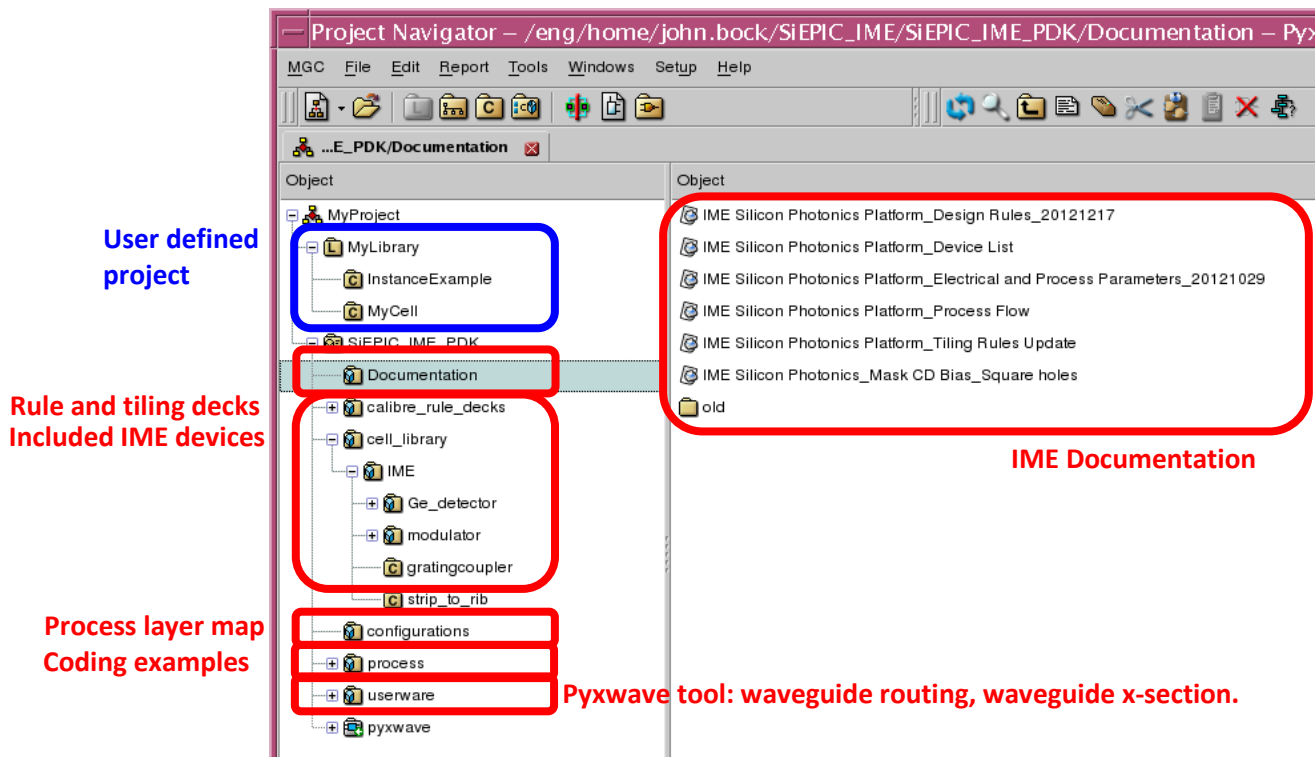


Figure 21: Overview of the PDK Components

4. Layout Operation

This section describes some fundamental layout operations:

- Drawing a Basic Structure
- Adding an Instance
- Understanding the Basic Drawing Commands

The annotations in Figure 22 describe the **Pyxis Layout** window.

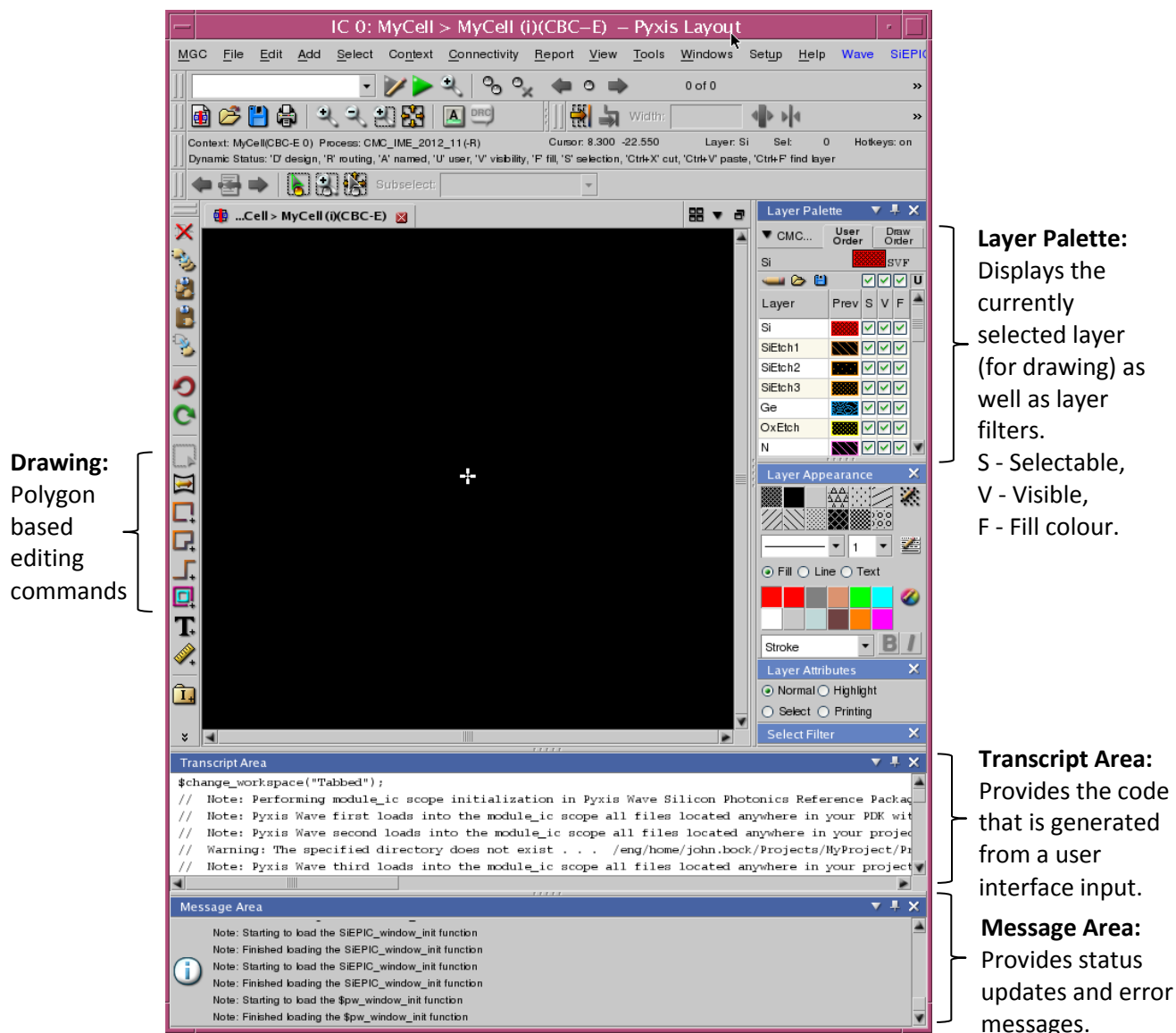


Figure 22: Pyxis Layout Main Panels

4.1. Drawing a Basic Structure

Basic drawing functionality is demonstrated by drawing and changing the parameters of a simple waveguide:

1. Draw a waveguide by doing the following:
 - a. In the panel **Layer Palette**, select the layer **Si**.
Note: For details about the layers, refer to Table 1 on page 45.
 - b. On the left list of icons, click **Add Rectangle**.
 - c. In the center pane drawing space, draw a rectangle (see Figure 23).

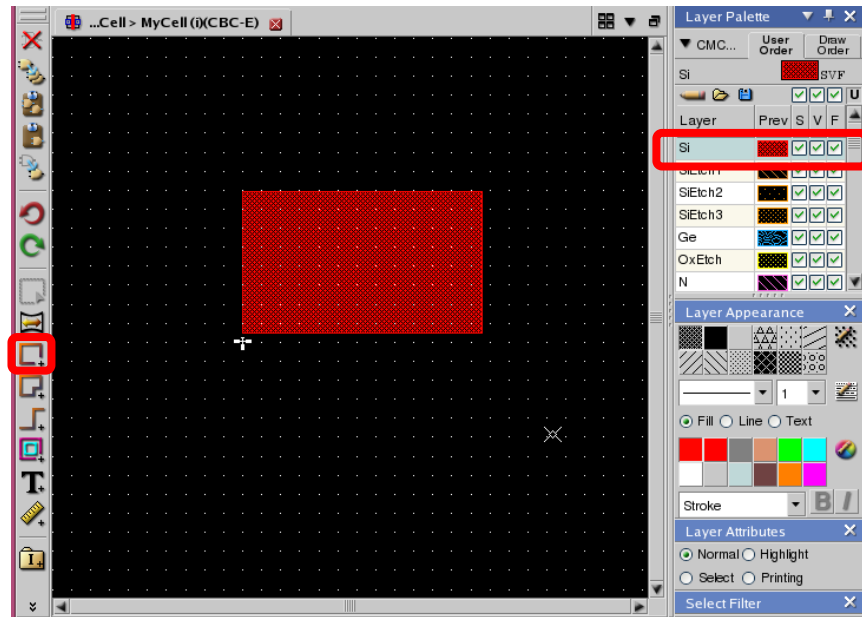


Figure 23: Drawing Rectangular Waveguide

Note: To zoom in and out either use the mouse scroll wheel or, on the main menu, choose **View | Zoom**.

2. Change the parameters of the rectangle:
 - a. Click the rectangle to select it.
 - b. On the keyboard, press <Q>.

The **Edit Object** dialog box displays.

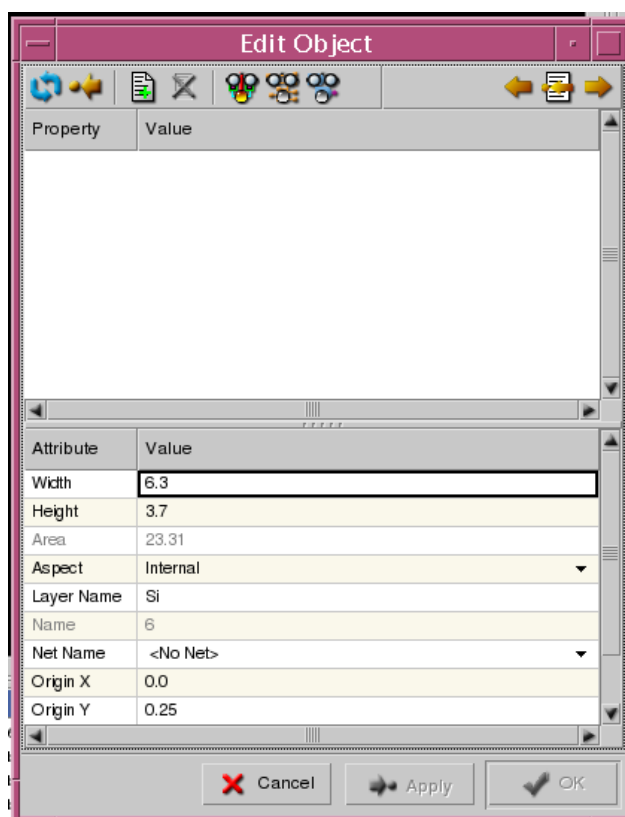


Figure 24: Edit Object Dialog Box

- c. In the dialog box, change the values of these attributes:
 - **Width:** 10
 - **Height:** 0.5
 - **Origin Y:** -0.25
- d. Click **OK**.

Note: Instead of drawing a rectangle and changing the attributes using the **Edit Object** dialog box, you can create a rectangle using code:

- i. In the transcript area, copy the line of code that generated the original rectangle (see Figure 25).

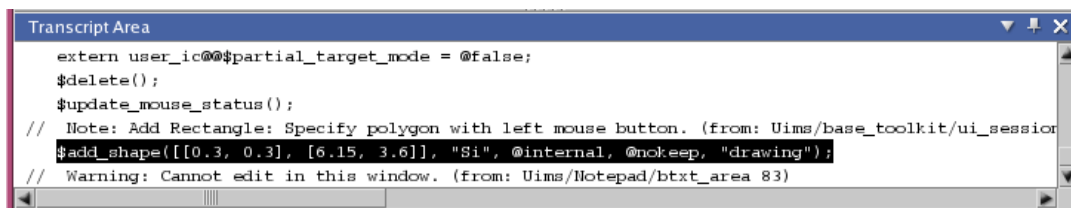


Figure 25: Rectangle Attributes in Transcription Area

- ii. In the main drawing area, press **<spacebar>** to display the command line prompt.
- iii. Paste the code into the command line then modify the attributes to the previously stated values (see Figure 26). Note that this creates a new rectangle in the layout.

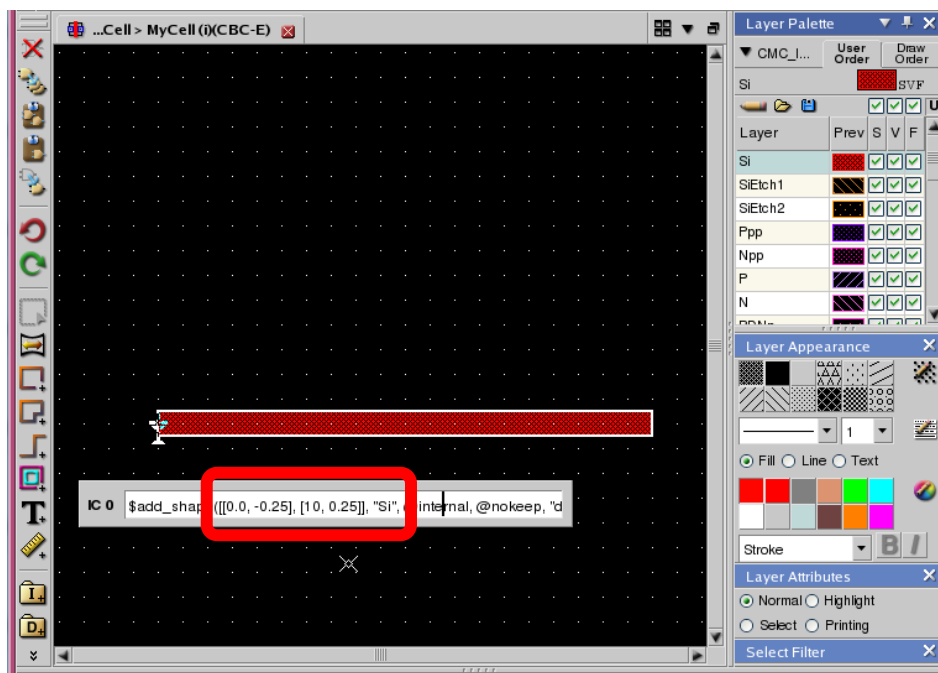


Figure 26: Changing Rectangle Attributes Using Command Prompt

- iv. Press **<Enter>**.
3. On the main menu, choose **MGC | Exit** to exit.

The **Close Session** dialog box appears.

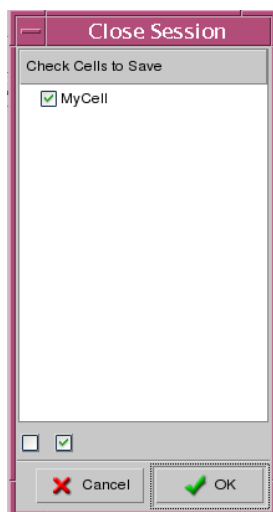


Figure 27: Close Session Dialog Box

4. Click **OK** to confirm the exit.

Note: By default, the cell changes are saved. If you do not want to save the changes, then either uncheck the cell in the main pane or use the **check/uncheck all** buttons at the bottom left.

4.2. Adding an Instance

To add an instance:

1. Under **MyLibrary**, create a new cell named **InstanceExample** (see Figure 14 on page 15).
2. Create a new layout in this cell by the same name (see Figure 16 on page 15).

Pyxis Layout starts automatically.

3. Press <I>.

The **File Browser** dialog box appears.

4. Navigate to **MyLibrary/MyCell/MyCell** layout then select it (see Figure 28).

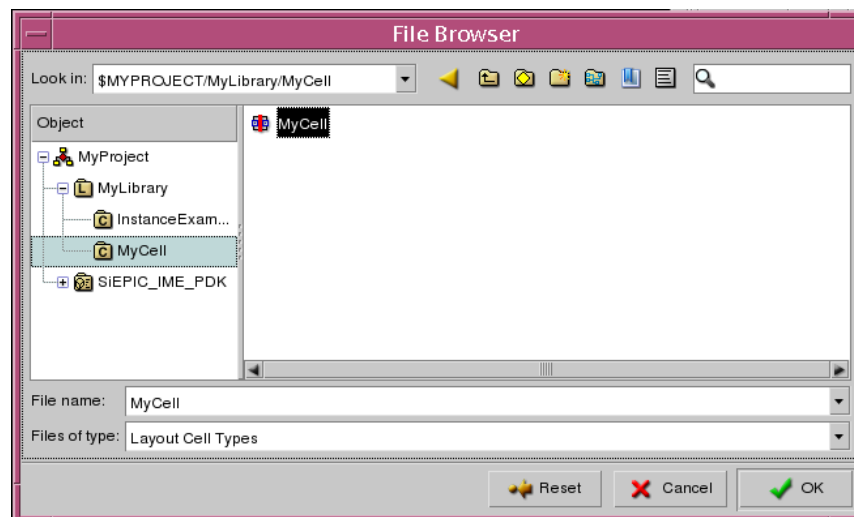


Figure 28: File Browser Dialog Box

5. Click three times in the drawing space to create three instances of **MyCell**.

Note: Each click creates one instance (see Figure 29).

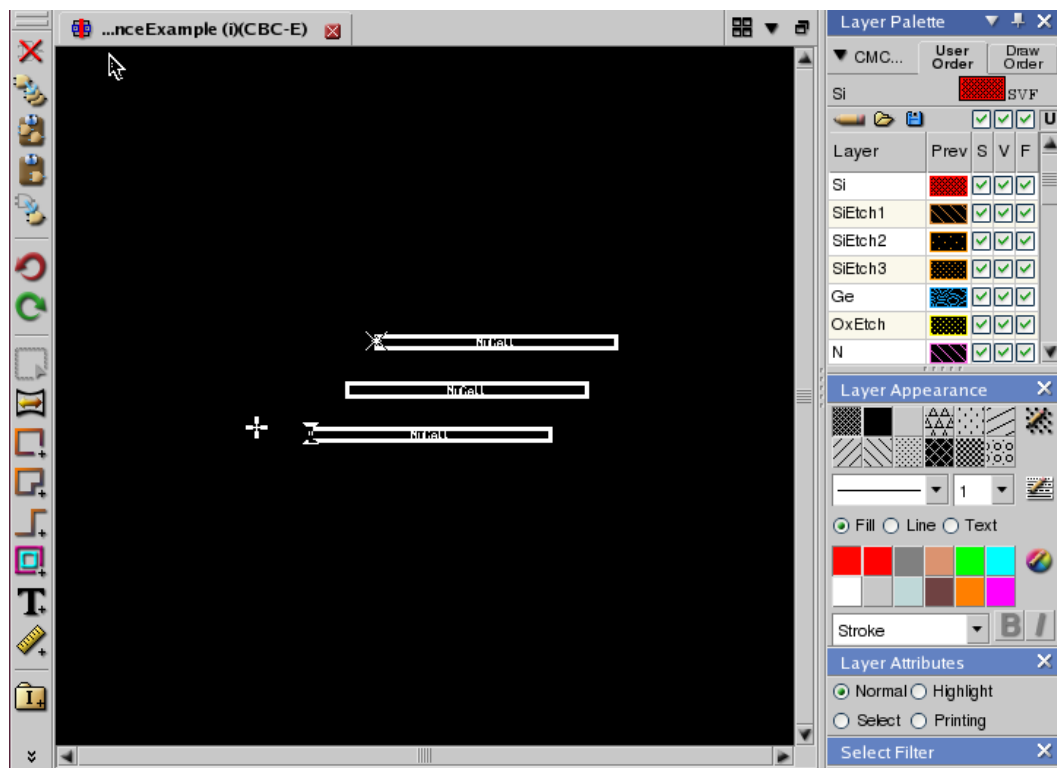


Figure 29: Creating Three MyCell Instances

6. Press <Esc> then press <Shift+F> to peak.

Note: Peak refers to making visible the entire hierarchy of a cell, in this case **InstanceExample** (see Figure 30).

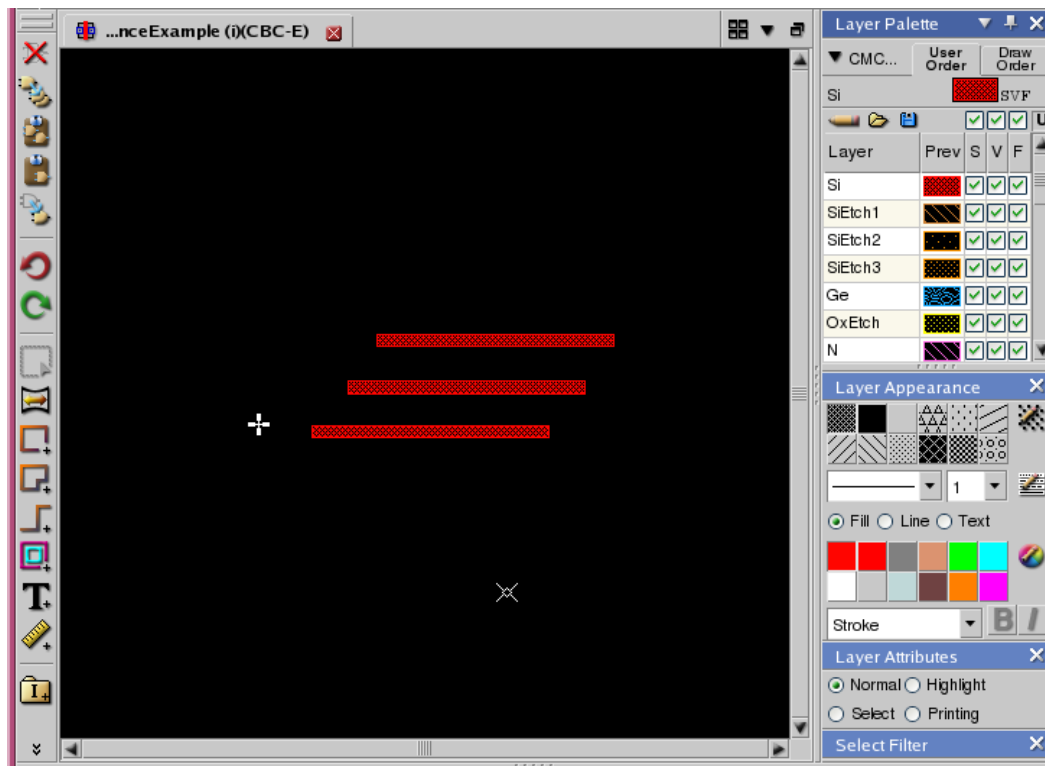


Figure 30: Drawn Instances

7. Press <I> again.

Note: **MyCell** is still set as the active cell to instantiate.

8. To change the active cell to instantiate:
 - a. Press <Q>.

The **Add array** dialog box displays.

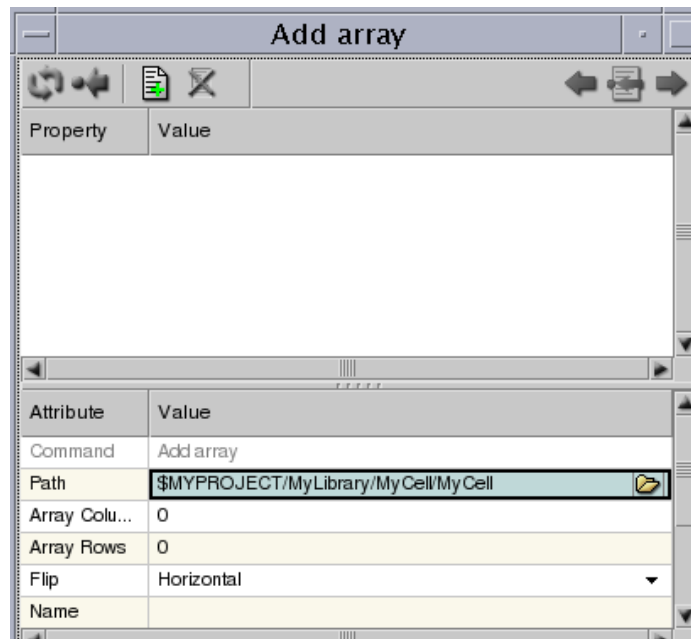


Figure 31: Add Array Dialog Box

- b. To the right of the **Path** attribute, click the icon **Open Folder**.

The **File Browser** dialog box displays.

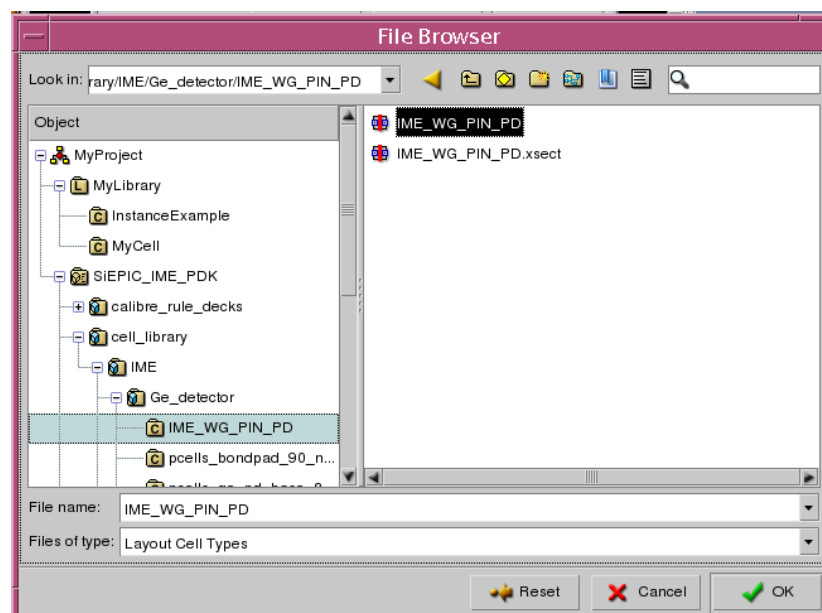


Figure 32: File Browser Dialog Box

- c. In the new dialog box, do the following:
 - i. Navigate to
`SiEPIC_IME_PDK/cell_library/IME/Ge_detector/IME_WG_PIN_PD`.
 - ii. Select `IME_WG_PIN_PD`.
 - iii. Click **OK**.
 - d. In the **Add array** dialog box, click **OK**.
9. Press <Esc> then press <Shift+F> to peak at the hierarchy.

Note: Since this structure is large compared to **MyCell**, zooming out may be required. The layout should look similar to Figure 33.

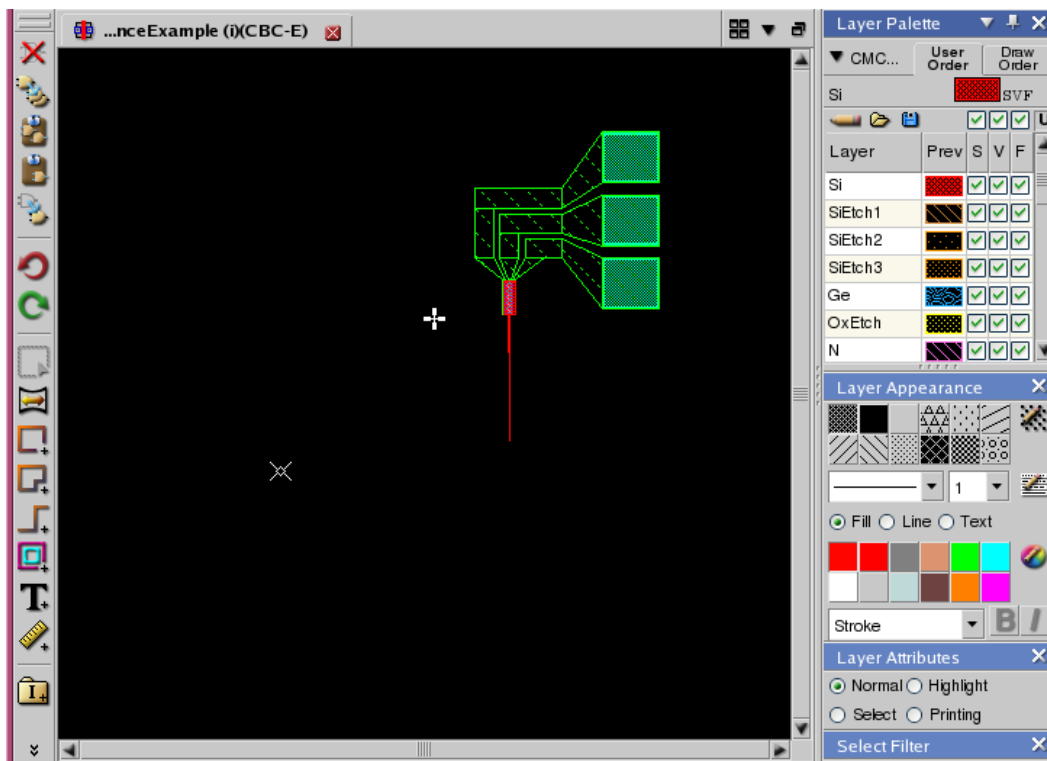


Figure 33: Zoomed-out View of the Layout

4.3. Understanding the Basic Drawing Commands

This section describes four basic drawing commands:

- Move
- Align
- Move Rel
- Rotate

4.3.1. Move

The **move** command allows you to move a structure.

To use the **move** command:

1. Zoom in on the three instances of **MyCell** then select the bottom one.

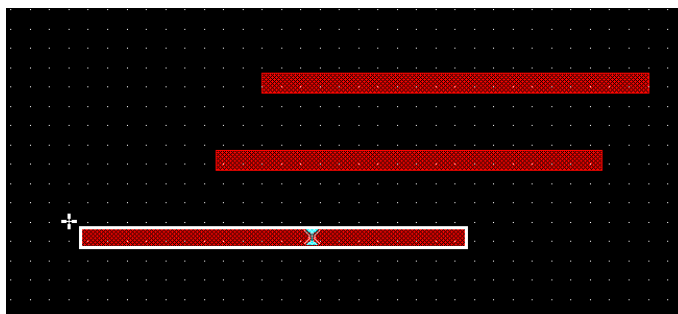


Figure 34: Selecting the Bottom Instance

2. Zoom in close until you can click the exact corner. This sets the drawing base-pointer to the left bottom corner of the selected structure.

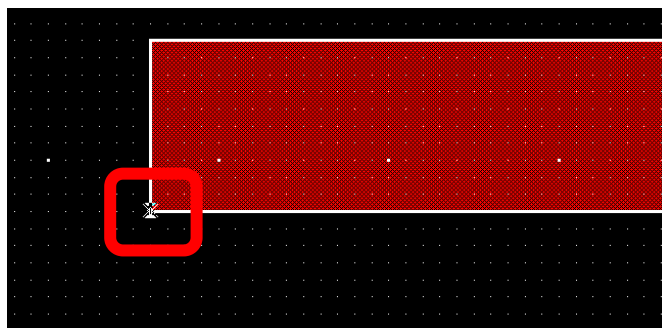


Figure 35: Setting Base Pointer to the Structure's Corner

3. Press **<spacebar>** to display the command prompt.
4. Type **move** then press **<Enter>**. This instance of **MyCell** is now movable by the previously selected base pointer.

5. Press <V> to activate alignment helpers.
6. With the mouse, move the instance to align with the middle **MyCell** instance (see Figure 36).

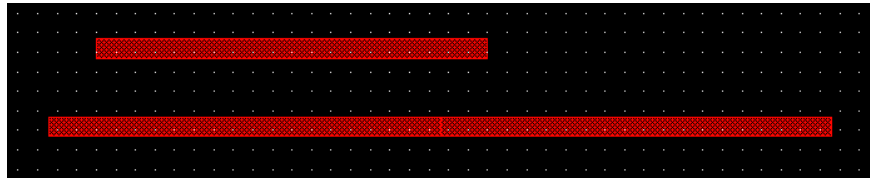


Figure 36: Bottom Instance Aligned with the Middle Instance

4.3.2. Align

The **align** command allows you to move a structure and align it with another item.

To use the **align** command:

1. Select the **MyCell** instance at the top.

Note: You do not need to set the base-pointer to a specific location.

2. Press the <spacebar> to display the command prompt.
3. Type **align** then press <Enter>.
4. Click on the previously-moved **MyCell** instance.

The **Align** dialog box displays.

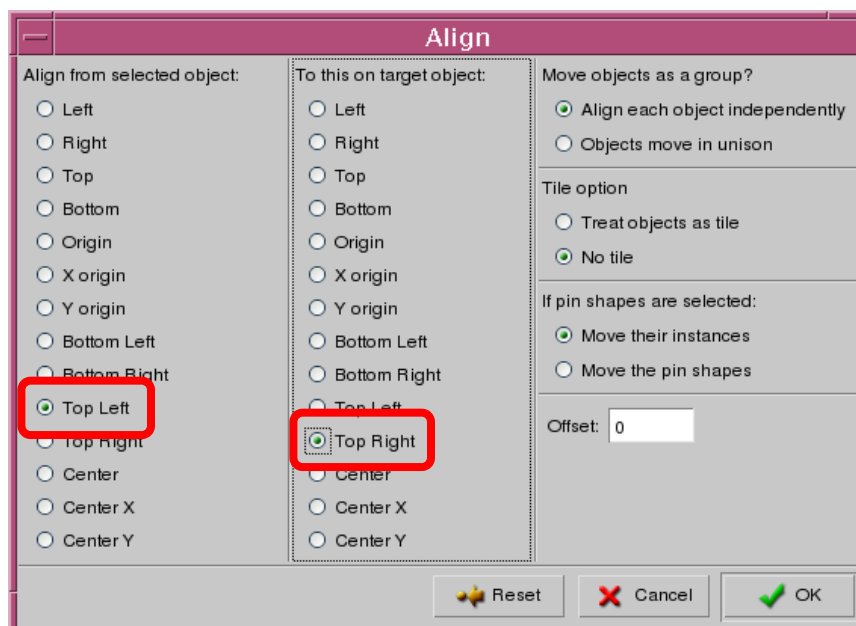


Figure 37: Align Dialog Box

5. To complete the alignment, do the following:
 - a. In the left pane under **Align from selected object**, select **Top Left**.
 - b. In the center pane under **To this on target object**, select **Top Right**.
 - c. Click **OK**.

The top cell is aligned with the previously moved **MyCell** instance (see Figure 38).



Figure 38: Layout after Using the Align Command

4.3.3. Move Rel

The **move rel** (that is, move relative) command allows you to move a structure relative to another item.

To use the **move rel** command:

1. Select the leftmost **MyCell** instance.
2. Press the **<spacebar>** to display the command prompt.

3. Type `move rel` then press <Enter>.

A panel displays at the bottom left of the drawing area (see Figure 39).

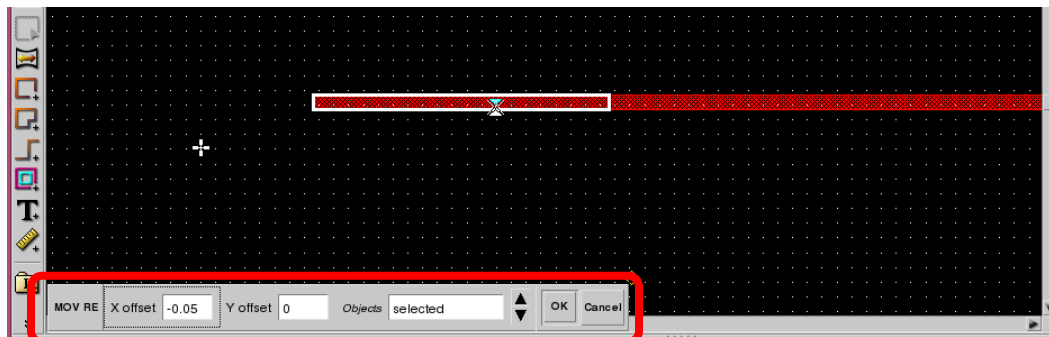


Figure 39: Move Relative Panel

4. In the panel, do the following:
 - a. Set the **X offset** to `-0.05` (that is, 50 nm to the left).
 - b. Click **OK**.

The leftmost **MyCell** instance moves 50 nm to the left, leaving a 50 nm gap between it and the other **MyCell** instance (see Figure 40).

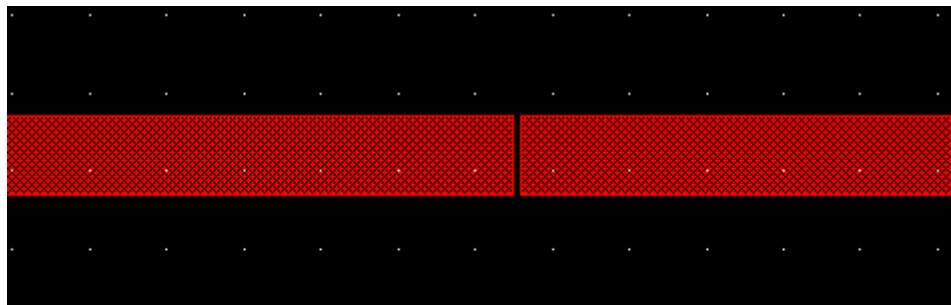


Figure 40: Move Relative Command Results in a 50 nm Gap

5. Save the layout. This gap will be used in the rule checking example in the next section, **Running a Design Rule Check**.

4.3.4. Rotate

The `rotate` command allows you to rotate a structure.

To use the `rotate` command:

1. Select the rightmost **MyCell** instance.

2. Set the base pointer to the middle of the rightmost edge (see Figure 41).

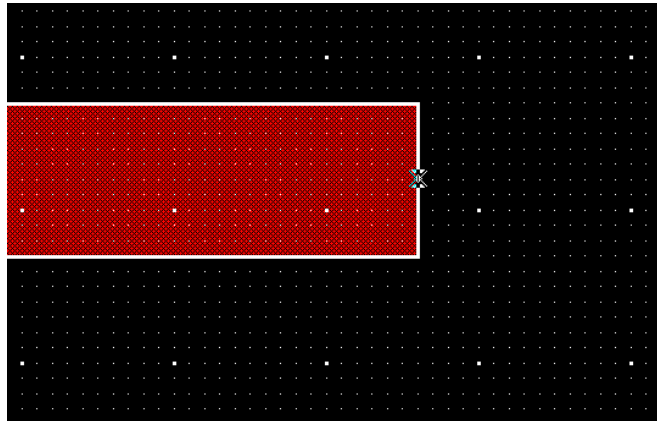


Figure 41: Setting Base Pointer to Middle of Edge

3. Press **<spacebar>** to display the command prompt.
4. Type **rotate 90** then press **<Enter>**.

The instance is rotated 90 degrees about the base pointer (see Figure 42).

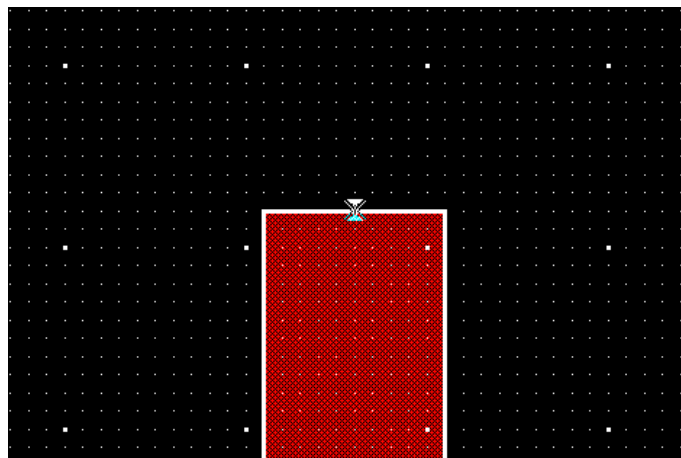


Figure 42: Rotate Command Result

5. Running a Design Rule Check

To run a design rule check (DRC):

1. In the **Layer Palette** panel, select the floorplan layer **fp**.
2. Draw a box encompassing all drawn structures (see Figure 43).

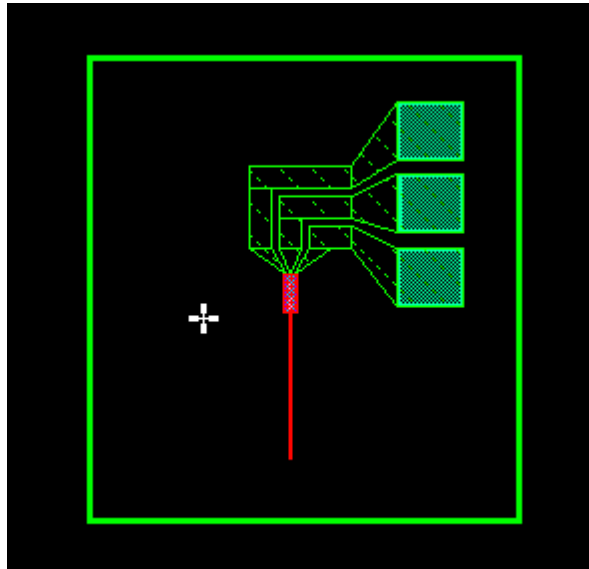


Figure 43: Floorplan Layer Encompassing All Drawn Structures

Note: At this zoom setting, the **MyCell** instances are not visible. Ensure that all drawn structures are on the floorplan layer **fp**. The floorplan layer represents the total design space available.

3. To run the design rule check, use one of these methods:
 - a. **Viewing Area DRC**, or
 - b. **Full DRC**.

a. Viewing Area DRC

For this method, a DRC runs only on those structures currently shown in the layout view. This method is useful for quickly checking small areas while you are drawing/designing.

- i. On the toolbar, click the icon **Run DRC** (see Figure 44).

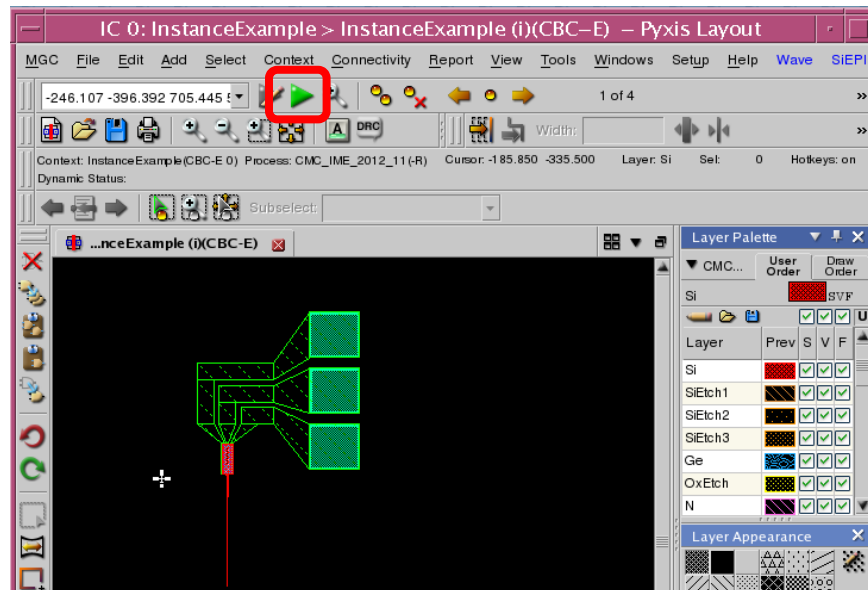


Figure 44: Running DRC on the Currently Viewed Area

b. Full DRC

For this method, a DRC runs on the entire layout. This method displays violations in a separate window and is incredibly useful to find, understand, and correct violations.

- i. On the main menu, choose **Tools | Calibre | Run DRC**.

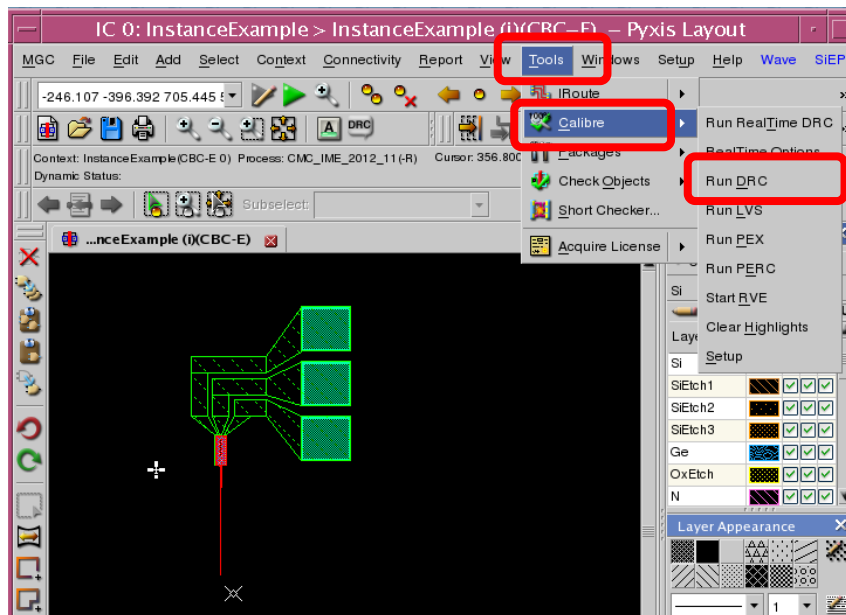


Figure 45: Running DRC on Entire Layout

The **Calibre Interactive** window displays with the settings automatically populated.

Note: It may take several seconds for the window to open.

- ii. On the **Calibre Interactive** main menu, choose **Setup | DRC Options** (see Figure 46).

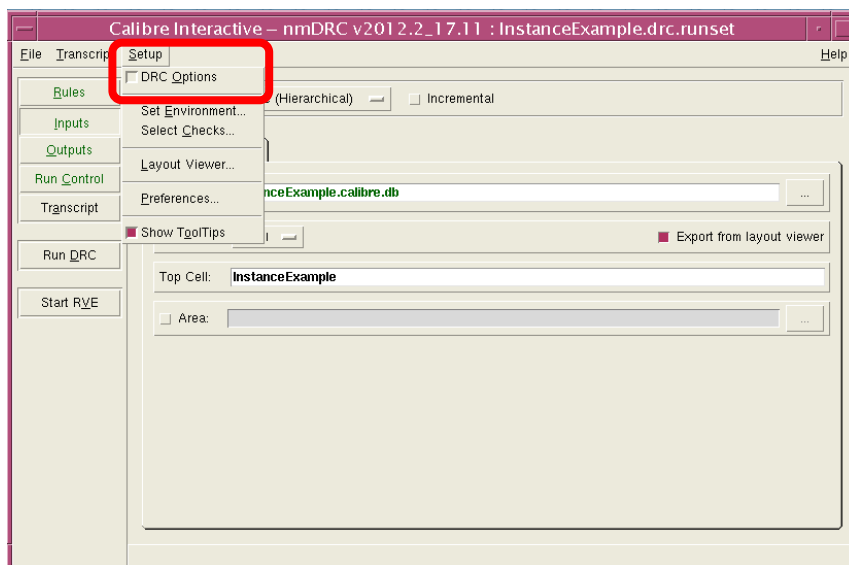


Figure 46: Calibre Interactive Dialog Box

The panel **DRC Options** displays.

- iii. In **Max errors generated per check** and **Max vertices in output polygon**, choose **All**.

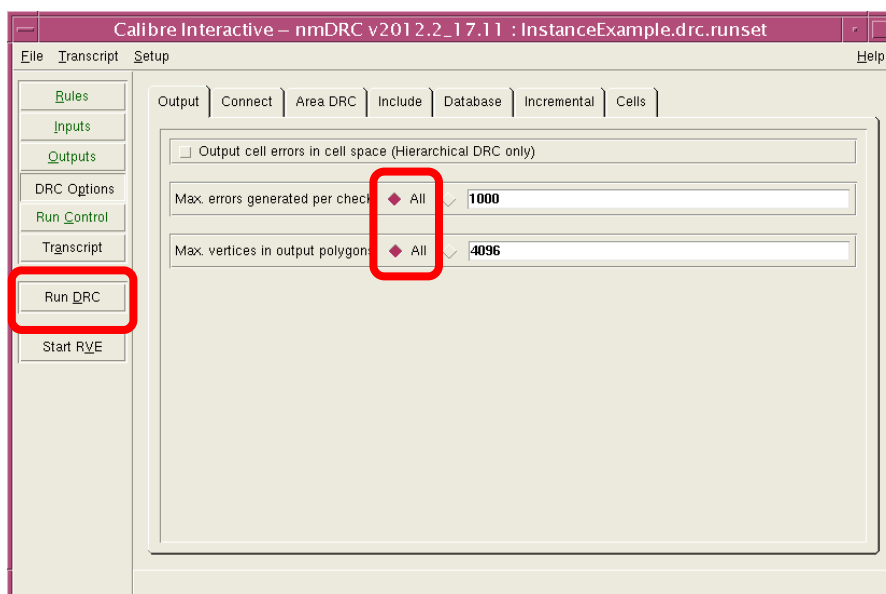


Figure 47: DRC Output Settings

- iv. Click **Run DRC**.

The **Transcript** panel displays in the **Calibre Interactive** dialog and a **DRC Summary** window displays while the DRC is running.

When the DRC run is complete, the results window displays (see Figure 48).

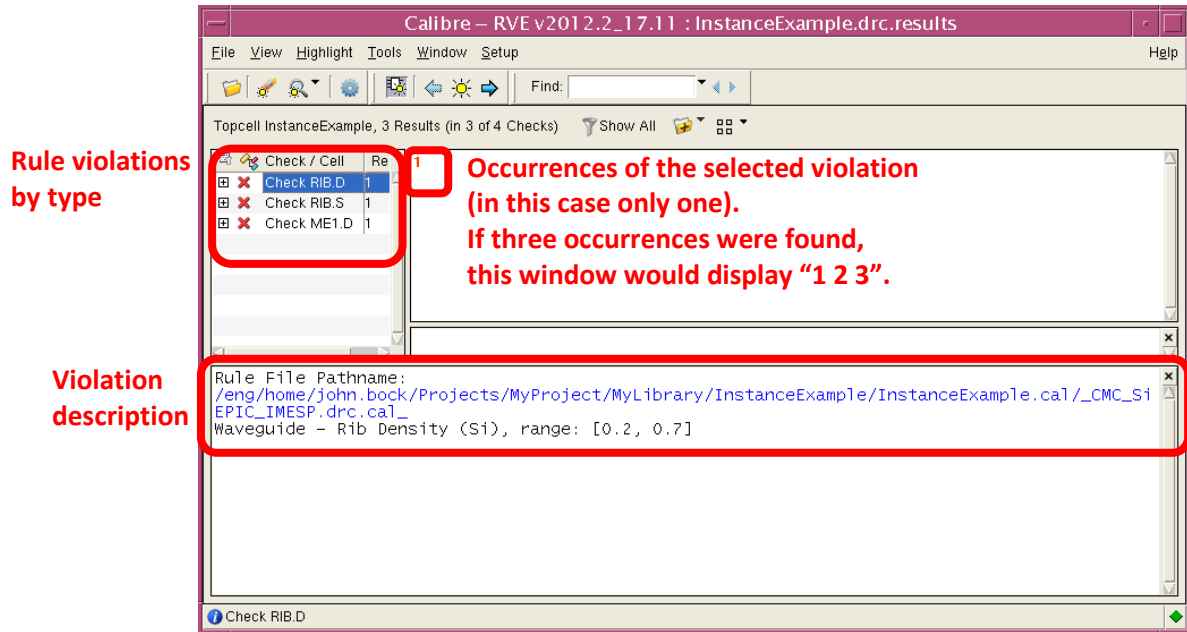


Figure 48: Design Rule Check Results

Note: In the example above, three types of errors have been found, with one occurrence of each. The first and third violations are expected because the layout has not yet been tiled. This lack of tiling results in the density rules for **Si** and for **M1** to be violated. This will be fixed once the layout is tiled at a later time.

- v. Select the second violation type then double-click the number **2** (this number refers to the second violation found in total out of all violations).

The error that was previously introduced in the section **Understanding the Basic Drawing Commands** is identified (see Figure 49).

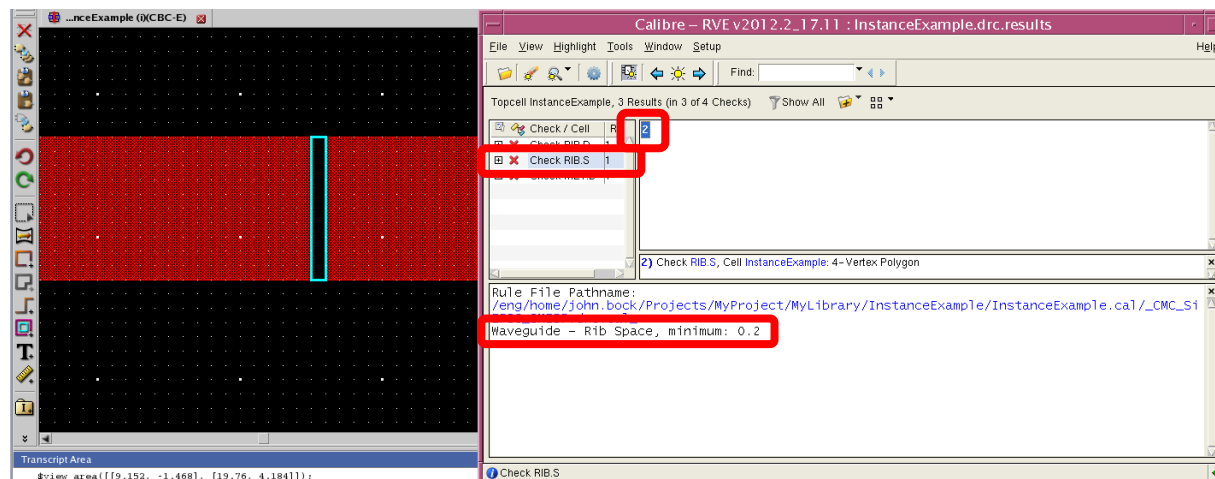


Figure 49: Investigating a DRC Violation

Note: The error occurred because the minimum spacing rule for the **Si** layer is 200 nm, whereas the introduced gap is only 50 nm.

6. Exporting/Importing GDS Files

6.1. Exporting

To export the **InstanceExample** layout:

1. Open the **InstanceExample** in Pyxis layout editor by selecting **File | Export | GDSII**.

The **Write GDSII** dialog box displays.

2. In the field **Output GDS file**, select the path and name of the resulting GDS file (see Figure 50) then click **OK**.

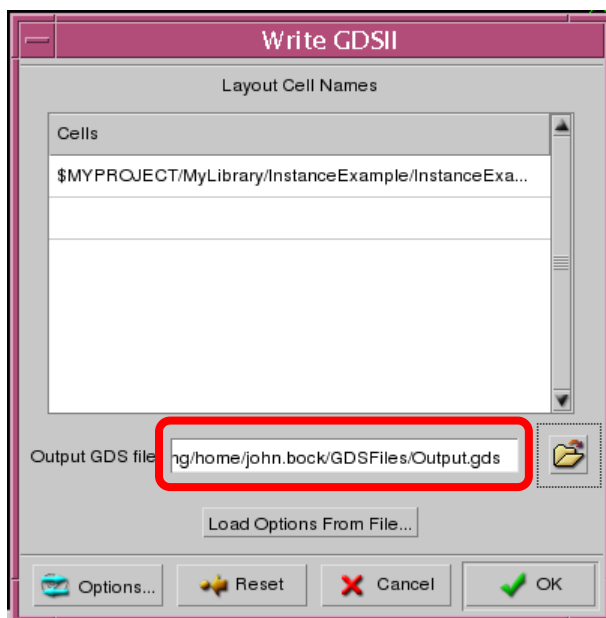


Figure 50: Write GDSII Dialog Box

3. Close Pyxis Layout Editor.

6.2. Importing

To import the resulting **Output.gds** file:

1. Create a new library named **MyImport** then select it.

2. Right-click the new library then, in the dropdown menu, choose **Import | GDSII** (see Figure 51).

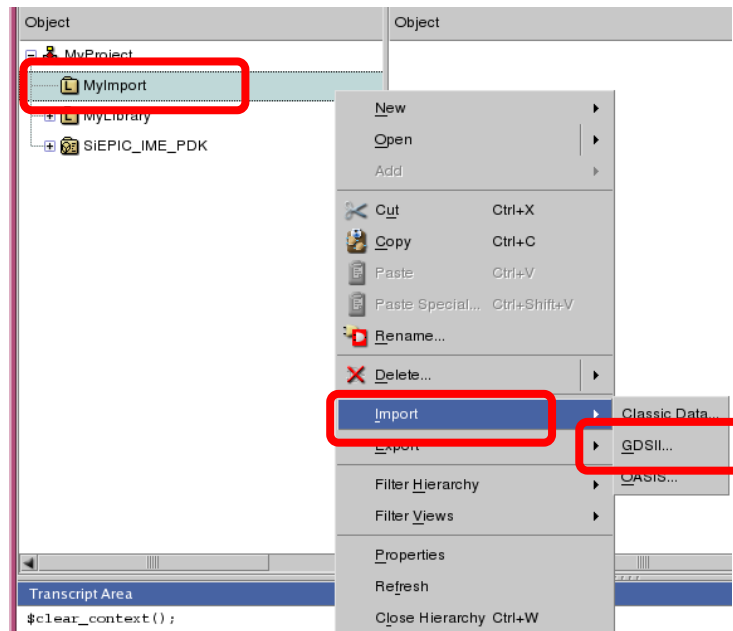


Figure 51: Importing a GDSII File

The **Import GDSII to Layout** dialog box displays.

3. In the field **GDSII file**, navigate to the location of the **.gds** file (see Figure 52) then click **OK**.

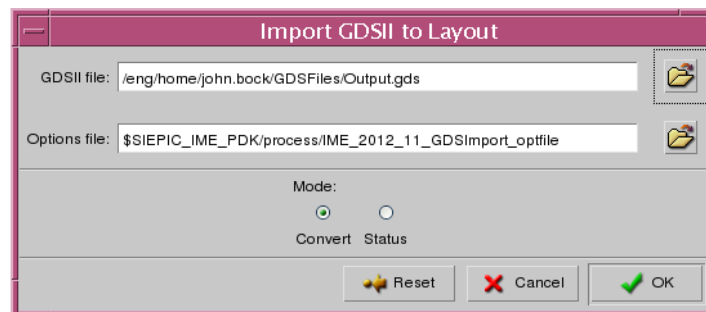


Figure 52: Import GDSII to Layout Dialog Box

Note: The field **Options file** is populated automatically.

4. Select **MyImport** then, on the toolbar, click the refresh icon (see Figure 53).

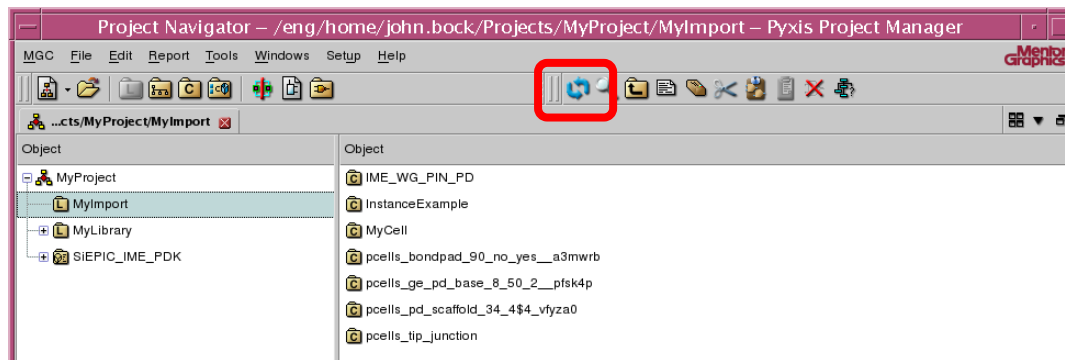


Figure 53: Refreshing the Imported Cells

Note: Not just the **InstanceExample** cell has been created but copies of all cells that **InstanceExample** instantiates including **MyCell** as well as all relevant cells from the IME photo detector.

7. Fracturing

Upon exporting to a GDSII file, Pyxis will fracture any polygon containing more than 200 points (x, y coordinate pairs) into several polygons each containing 200 points or less.

Double-fracturing is defined as a fracture line intersecting a common facet between two polygons. In Figure 54, the vertical fracture line of the upper polygon (an arc waveguide) intersects the facet of the lower polygon (a straight waveguide).



Figure 54: Double Fracturing

The vertical fracture line requires a point on the grid that is not collinear with the two vertices of the lower polygon. A gap forms as a result of the vertical fracture line end point being forced on the layout grid as shown in Figure 55.

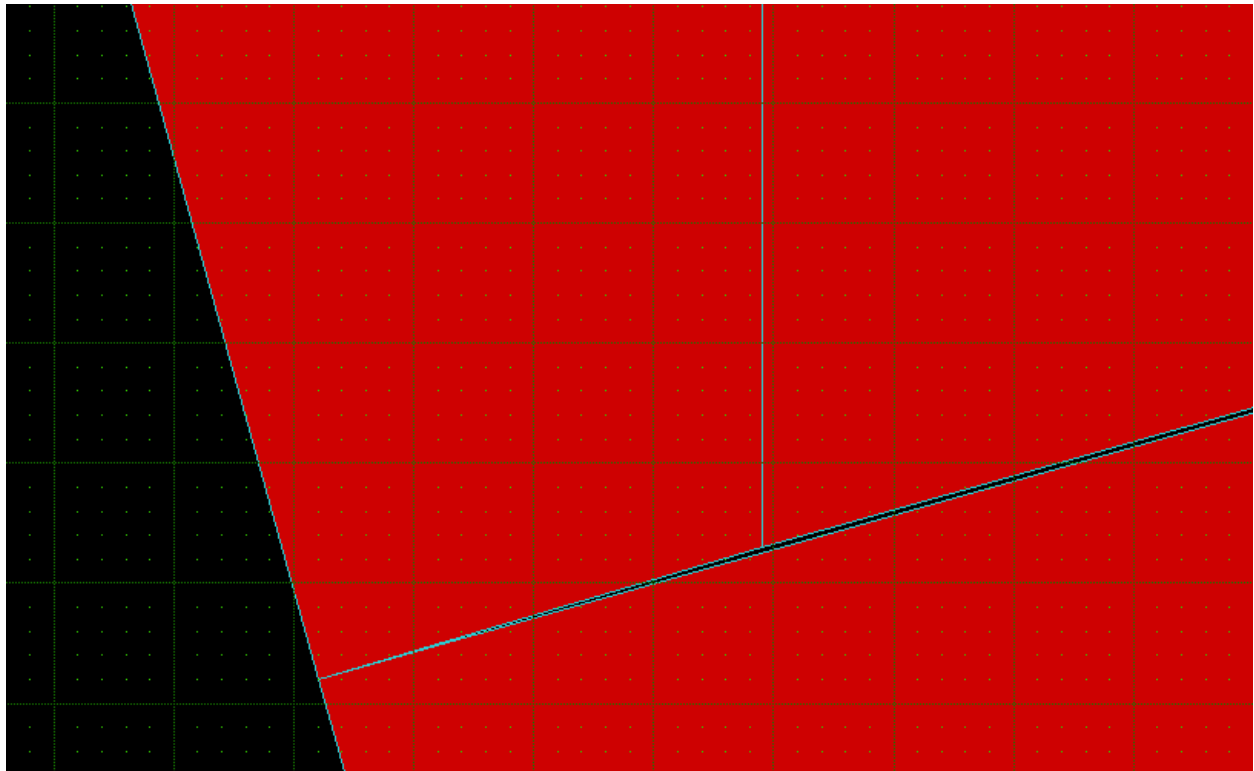


Figure 55: Gap Resulting from Double Fracturing

This gap would result in a minimum spacing DRC violation. After exporting a Pyxis layout to a GDSII file, we recommend that the exported file should be imported back into Pyxis to inspect the resultant fractures.

Appendix A. Layer Map

Table 1: Layer Map of IME Process and Equivalent Pyxis Layer Name

IME GDS Layer	Type	Pyxis Layer	Pyxis Name	Purpose
1	0	1	Si	220 nm Si Waveguide
2	0	2	SiEtch1	70 nm Si etch
3	0	3	SiEtch2	130 nm Si etch
4	0	27	PDPp	PD – Si P+ implant
5	0	25	Ppp	MOD+PD – Si P++ implant
6	0	24	Npp	MOD+PD – Si N++ implant
7	0	21	P	MOD – Si P implant
8	0	20	N	MOD – Si N implant
9	0	5	Ge	PD – Ge epi
10	0	26	GeNpp	PD – Ge N++ implant
11	0	40	VC	Via 1
12	0	41	M1	Metal 1
13	0	44	VL	Via 2
14	0	45	ML	Metal 2
15	0	46	MLOpen	Bond pad open
16	0	7	DT Oxide	Deep trench
17	0	6	OxEtch	Oxide etch to top of BOX
*25	0	23	Pp	MOD – Si P+ implant
*26	0	22	Np	MOD – Si N+ implant
Note: * Intermediate implantations may not be available on the current run. Confirm with CMC Microsystems.				