

KLayout Productivity Suite Documentation

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2025-11-28

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1 Introduction

1.1 About KLayout Productivity Suite

KLayout is an open source VLSI layout viewer and editor.

The *KLayout Productivity Suite* is a collection of plugins developed by the **Department for Integrated Circuits (ICD), Johannes Kepler University (JKU)** to enhance your layout design productivity.

The available plugins are listed in the table below.

| Title | Description | Repository URL |
|--------------------------|---|---|
| Align Tool Plugin | Tool to align layout objects | https://github.com/iic-jku/klayout-align-tool |
| Automatic Backups | Create automatic backups of edited layouts | https://github.com/iic-jku/klayout-auto-backup |
| Layer Shortcuts Plugin | Shortcuts to quickly change layer visibility | https://github.com/iic-jku/klayout-layer-shortcuts |
| Library Manager Plugin | Library manager for hierarchical layouts | https://github.com/iic-jku/klayout-library-manager |
| Move Quickly Tool Plugin | Tool to quickly move layout objects | https://github.com/iic-jku/klayout-move-tool |
| Pin Tool Plugin | Efficient placement of pins | https://github.com/iic-jku/klayout-pin-tool |
| Plugin Utilities Library | Utility library used by various IIC KLayout plugins | https://github.com/iic-jku/klayout-plugin-utils |

Tip

The *KLayout Productivity Suite* source code itself is made publicly available on GitHub and shared under the GPL-3.0 license (see links above in table above).

The *KLayout Productivity Suite documentation* source code is made publicly available on GitHub ([follow this link](#)) and shared under the Apache-2.0 license.

Please feel free to create issues and/or submit pull requests on GitHub to fix errors and omissions! The production of the tool and this document would be impossible without these (and many more) great open-source software products: **KLayout**, **Quarto**, **Python**, **ngspice**, **Numpy**, **Scipy**, **Matplotlib**, **Git**, **Docker**, **Ubuntu**, **Linux**...

1.2 Acknowledgements

This project is funded by the JKU/SAL IWS Lab, a collaboration of [Johannes Kepler University](#) and [Silicon Austria Labs](#).



**Institute for
Integrated Circuits and
Quantum Computing**

(a) Johannes Kepler University: Institute for Integrated Circuits and Quantum Computing



SAL

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1.3 Installation

Generally, the plugins can be installed using the KLayout Package Manager.

- **KLayoutProductivitySuite** acts as a meta-package that can be installed in KLayout's Package Manager. Once installed, it automatically pulls in all the plugins as **dependencies** through the `grain.xml`
- Alternatively, single plugins can be cherry-picked using the plugin title in the above table (without whitespace)

As for the dependencies, there are multiple options available.

1.3.1 Option 1: Using IIC-OSIC-TOOLS Docker Image

We provide a comprehensive, low entry barrier Docker image that comes pre-installed with most relevant open source ASIC tools, as well as the open PDKs. This is a pre-compiled Docker image which allows to do circuit design on a virtual machine on virtually any type of computing equipment (personal PC, Raspberry Pi, cloud server) on various operating systems (Windows, macOS, Linux).

For further information please look at the [Docker Hub page](#) and for detailed instructions at the [IIC-OSIC-TOOLS GitHub page](#).



Linux

In this document, we assume that users have a basic knowledge of Linux and how to operate it using the terminal (shell). If you are not yet familiar with Linux (which is basically a must when doing integrated circuit design as many tools are only available on Linux), then please check out a Linux introductory course or tutorial online, there are many resources available.

A summary of important Linux shell commands is provided in [IIC-JKU Linux Cheatsheet](#).

1.3.2 Option 2: Standalone Installation

- **KLayout** layout tool:
 - get the latest pre-built package version
 - or follow the build instructions
- **Skywater sky130A PDK**:
 - optional
 - `pip3 install --upgrade ciel` (install PDK package manager)
 - `ciel ls-remote --pdk sky130A` (retrieve available PDK releases)

- * for example PRE-RELEASE 0c1df35fd535299ea1ef74d1e9e15dedaeb34c32 (2024.12.11))
- ciel enable --pdk sky130A 0c1df35fd535299ea1ef74d1e9e15dedaeb34c32 (install a PDK version)
- PDK files now have been installed under \$HOME/.volare/sky130A
- IHP SG13G2 PDK:
 - optional
 - pip3 install --upgrade ciel (install PDK package manager)
 - ciel ls-remote --pdk ihp-sg13g2 (retrieve available PDK releases
 - * for example PRE-RELEASE cb7daaa8901016cf7c5d272dfa322c41f024931f (2025.07.18))
 - ciel enable --pdk ihp-sg13g2 cb7daaa8901016cf7c5d272dfa322c41f024931f (install a PDK version)
 - PDK files now have been installed under \$HOME/.volare/ihp-sg13g2

2 Align Tool

2.1 Motivation

Boost your layout productivity with quick alignments of layout elements, such as

- cell instances
- shapes (e.g. polygons, boxes, paths)

Choose constraints by selecting features, such as

- edges (the entire edge)
- points (edge end points or the edge middle point)

2.2 Usage

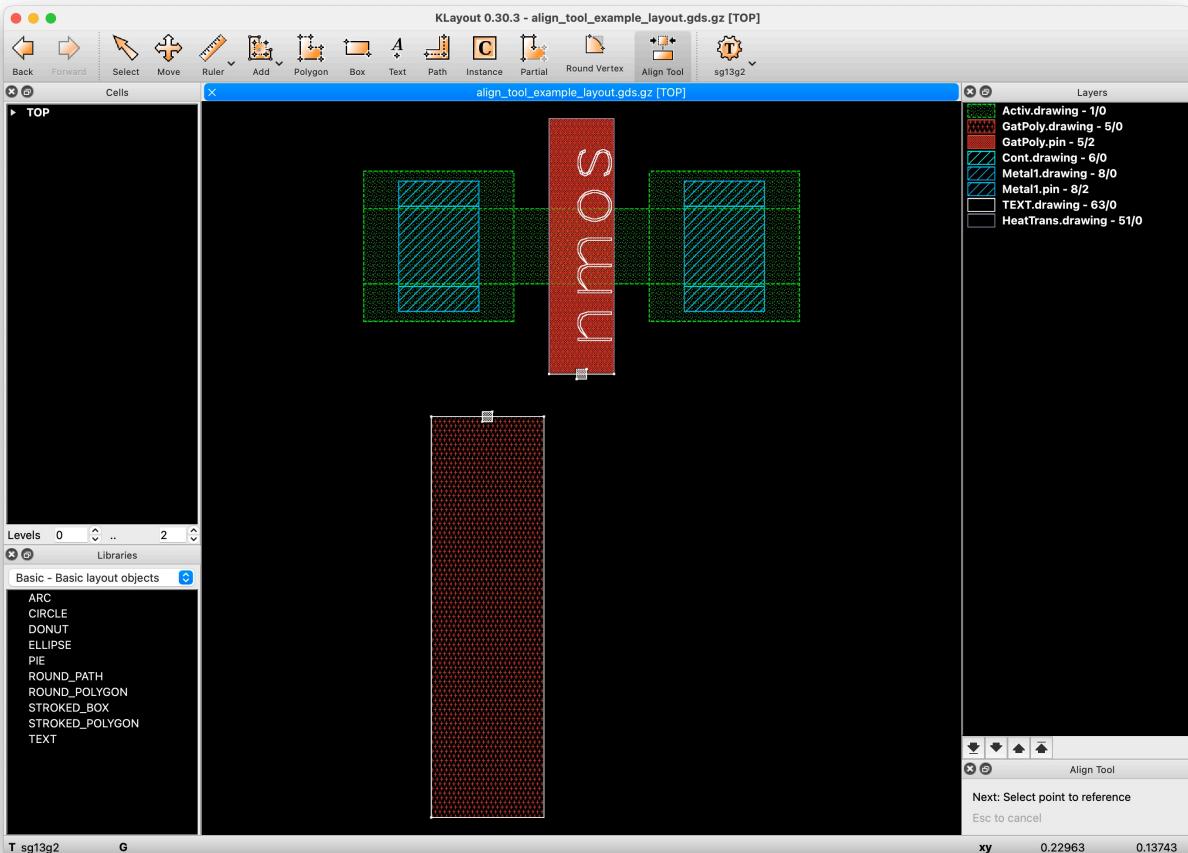


Figure 3: Align Tool

2.2.1 Pre-Selection

You can select instances and shapes (you want to align), prior to invoking the tool, thus making a *pre-selection*. The selection status will be displayed in the dock setup panel, as seen in Figure 4. If no pre-selection is made, the shape or instance of the source reference point is also the object being aligned.

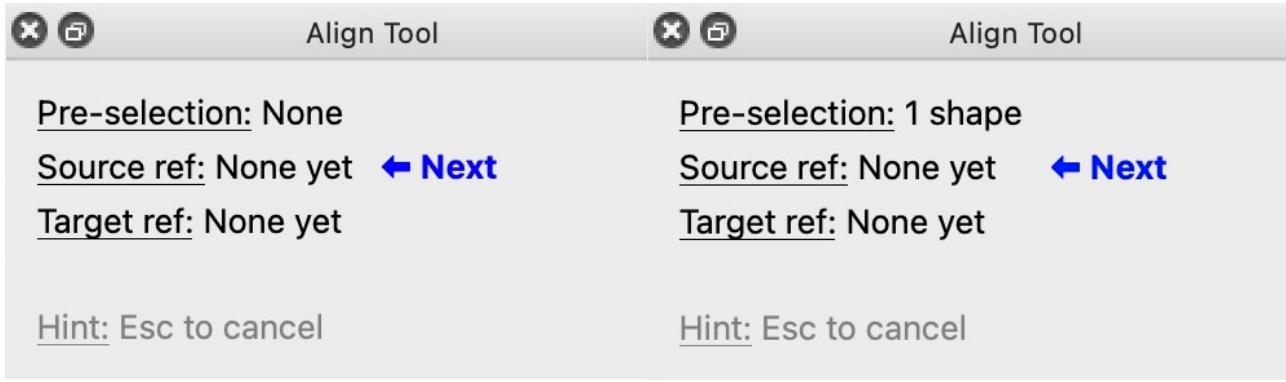


Figure 4: Dock Setup Panel

2.2.2 Selecting Features

Either points or edges can be chosen as the alignment reference.

1. Select the midpoint or one of the endpoints of an edge of a shape or instance bounding box. The search box is shown as a dashed rectangle
 - points must be within the search box
 - edges just intersect the search box
2. Left-click to apply the selection

2.2.3 Example 1: point-to-point alignment

1. Ensure there is no pre-selection
2. Click the *Align* tool (Figure 5)
 - or press A to enter the align mode (if you've configured the key binding [as explained here](#)).
3. Select feature of the shape to be moved/aligned, the *source reference* (Figure 6)
4. Select feature of the other shape that acts as the *target reference* (Figure 7)
5. Left-click to apply the alignment (Figure 8)
6. Alternatively, press Esc to cancel the operation

2.2.4 Example 2: edge-to-edge alignment

Notes on aligning edges to edges:

- edges must be parallel
- if the edge is too short and a point is always marked for selection, zoom in
- in edge-to-edge mode, alignment is performed only along the perpendicular axis, so
 - for horizontal edges: in the Y direction
 - for vertical edges: in the X direction

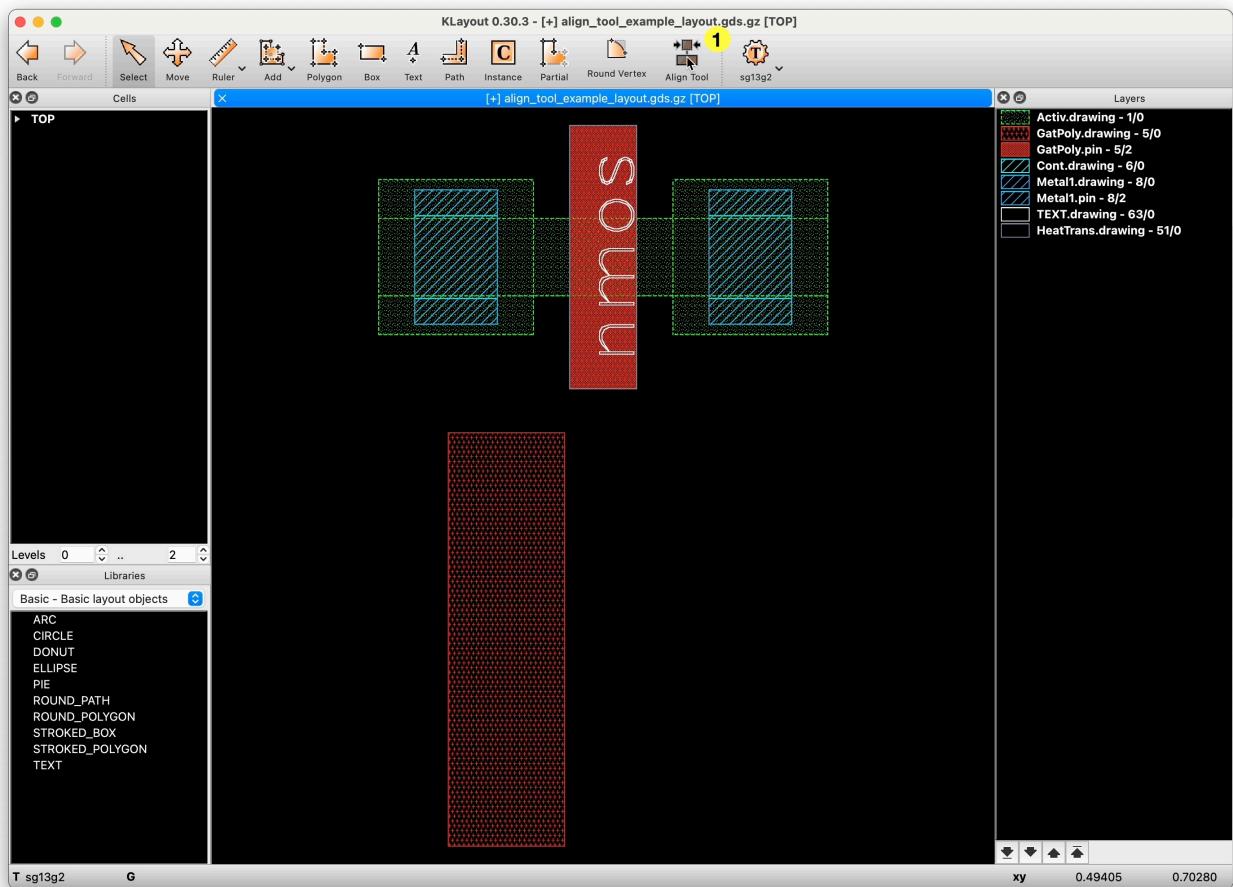


Figure 5: Select Align Tool

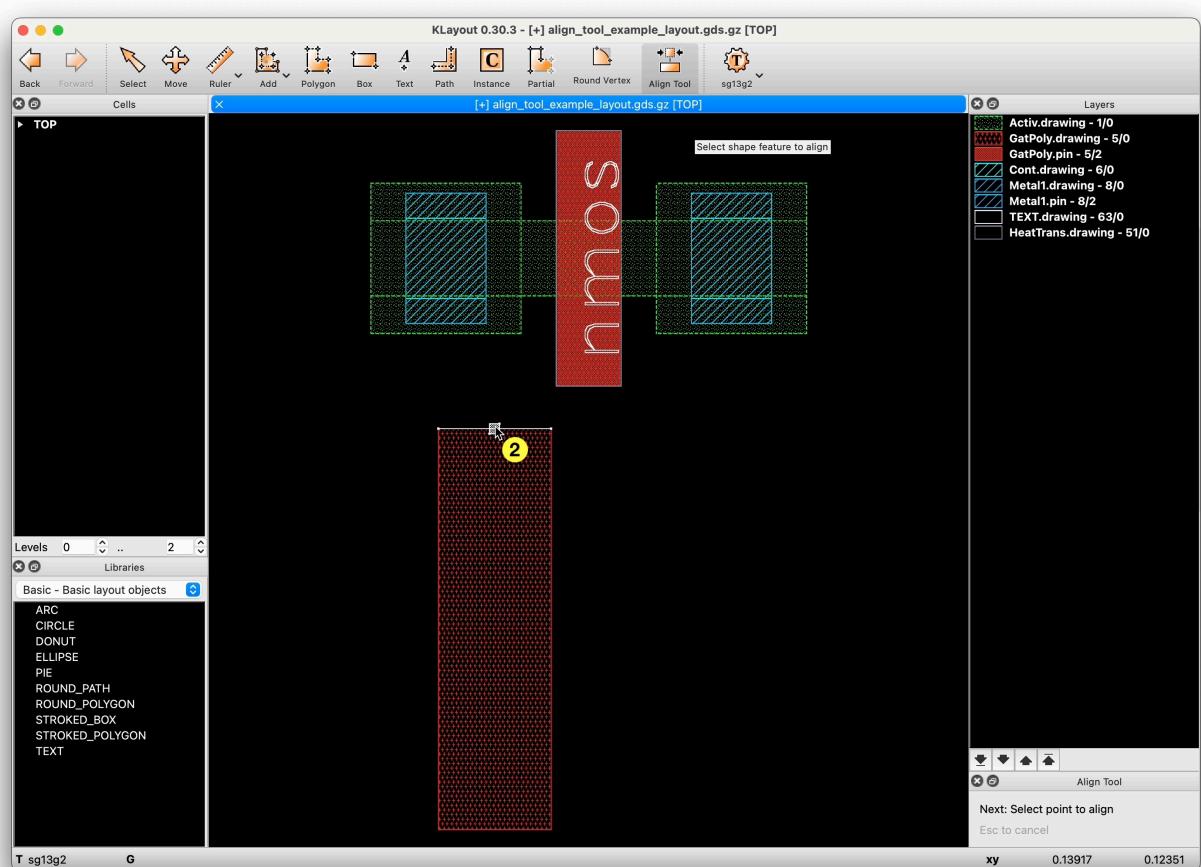


Figure 6: Select *source reference* point to align

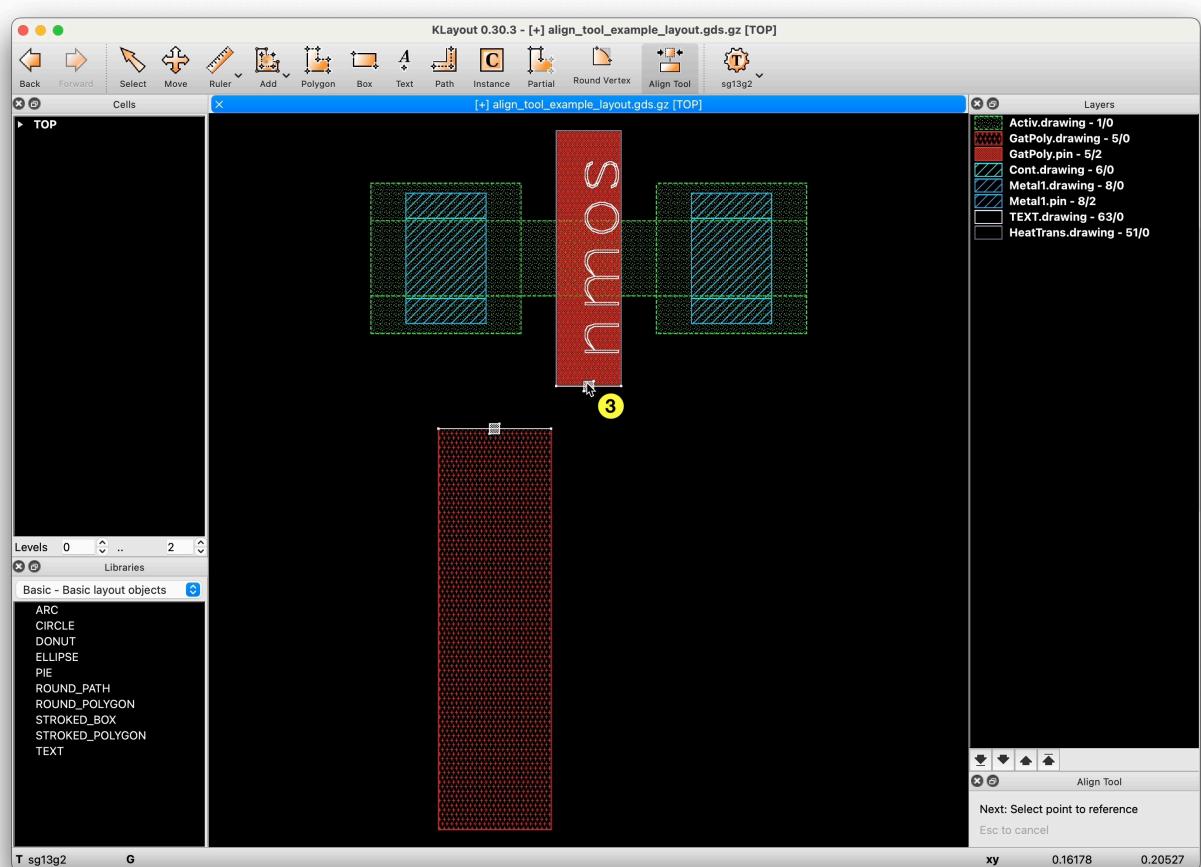


Figure 7: Select *target reference point* to move to

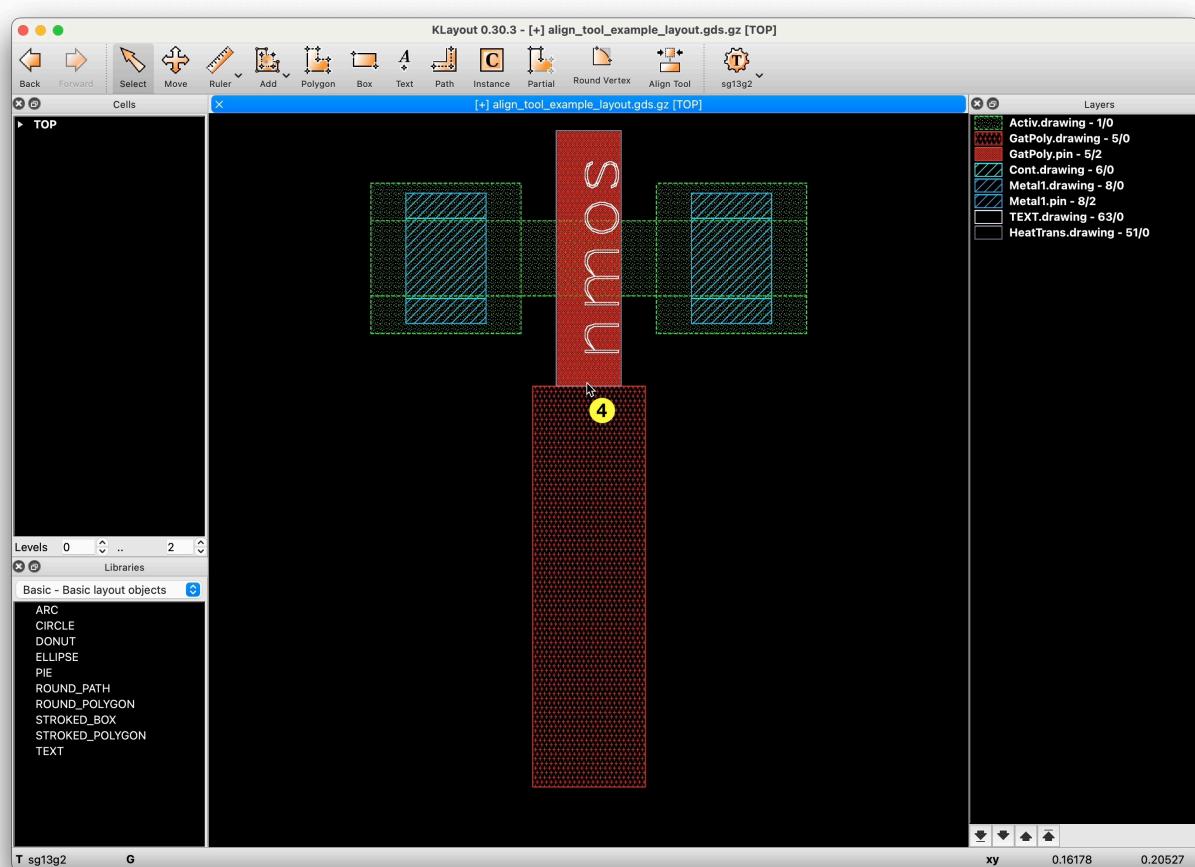


Figure 8: Alignment done

2.3 Assign key binding A to the tool

To configure a key binding:

- In the main menu, open the Preferences/Settings in KLayout
- Navigate to *Application*→*Customize Menu*
- Search for ‘Align’
- Assign the shortcut A to the path `edit_menu.mode_menu.Align`

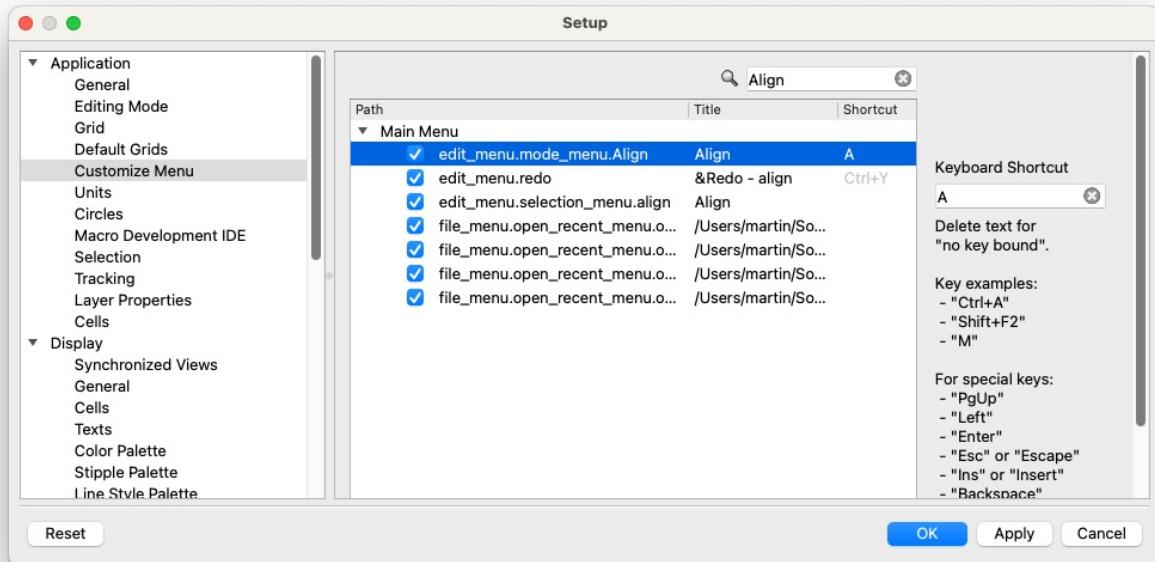


Figure 9: Assign key binding

3 Move Quickly Tool

Boost your layout productivity with quick moves of layout elements, such as

- cell instances
- shapes (e.g. polygons, boxes, paths)

3.1 Usage

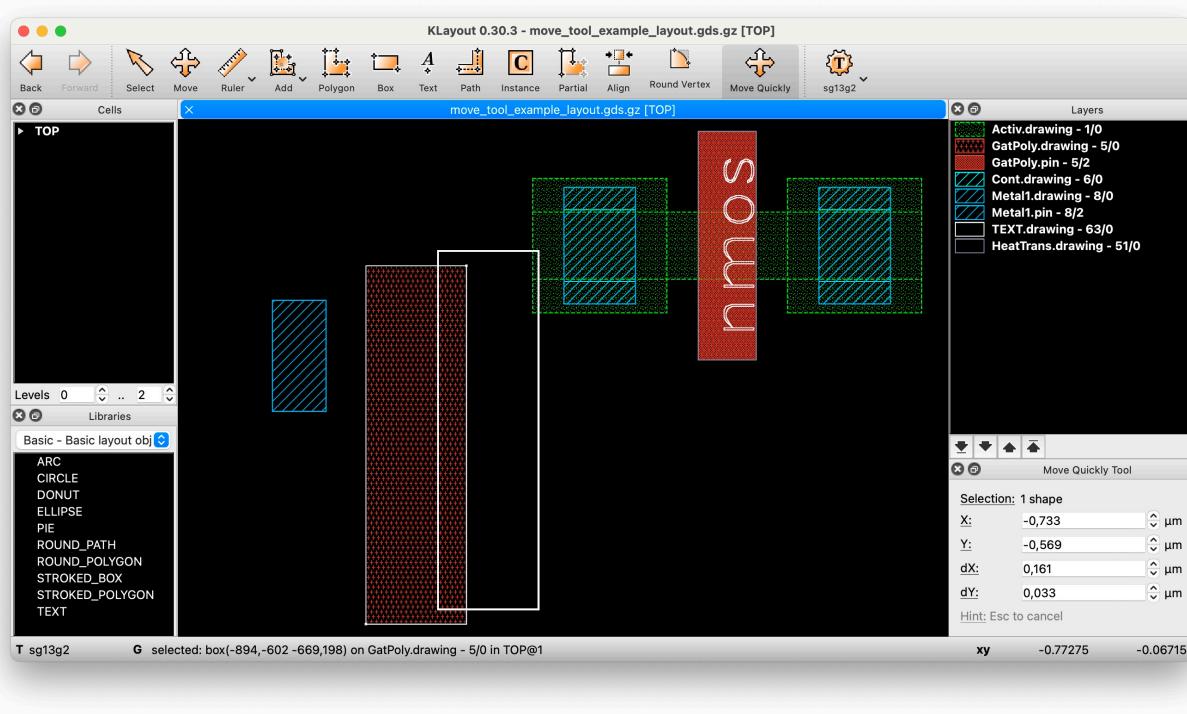


Figure 10: Move Quickly Tool

3.1.1 Pre-selection

- You can select instances and shapes (you want to move), before invoking the tool
 - The selection will be displayed in the dock setup panel

3.1.2 Tool activation and deactivation

- Click the *Move Quickly* tool or press M to enter the tool mode (if you've configured the key binding [as explained here](#))
- Press Esc at any time to abort the tool and activate the regular KLayout selection tool.

3.1.3 Example 1: Moving single object (mouse)

- Activate the tool
- If there is no selection, left-click an object to move it
- Otherwise, left-click again to move it
- Move the mouse to the destination
- Click to move the object

3.1.4 Example 2: Moving single object (keyboard)

- Activate the tool
- Left-click an object to select it
- Press **Tab** to enter the dock setup widget
- Provide either absolute positions or relativ deltas
- Press **Enter** to commit the move operation

3.1.5 Example 3: Extend selection

To keep the current selection, and extend it with additionally selected objects:

- Activate the tool
- Select an object
- Hold **Shift** and select additional object(s)
- Click to start moving
- Move the mouse to the desired destination
- Commit the move operation with a click or by pressing **Enter**

3.1.6 Example 4: Drag selection

- Activate the tool
- Select object(s) by dragging the mouse
- Hold **Shift** and select additional object(s)
- Click to start moving
- Move the mouse to the desired destination
- Commit the move operation with a click or by pressing **Enter**

3.2 Pro-Tip: assign key binding M to the tool

- In the main menu, open the Preferences/Settings in KLayout
- Navigate to *Application*→*Customize Menu*
- Search for ‘Move’
- Assign the shortcut M to the path `edit_menu.mode_menu.Move_quickly`

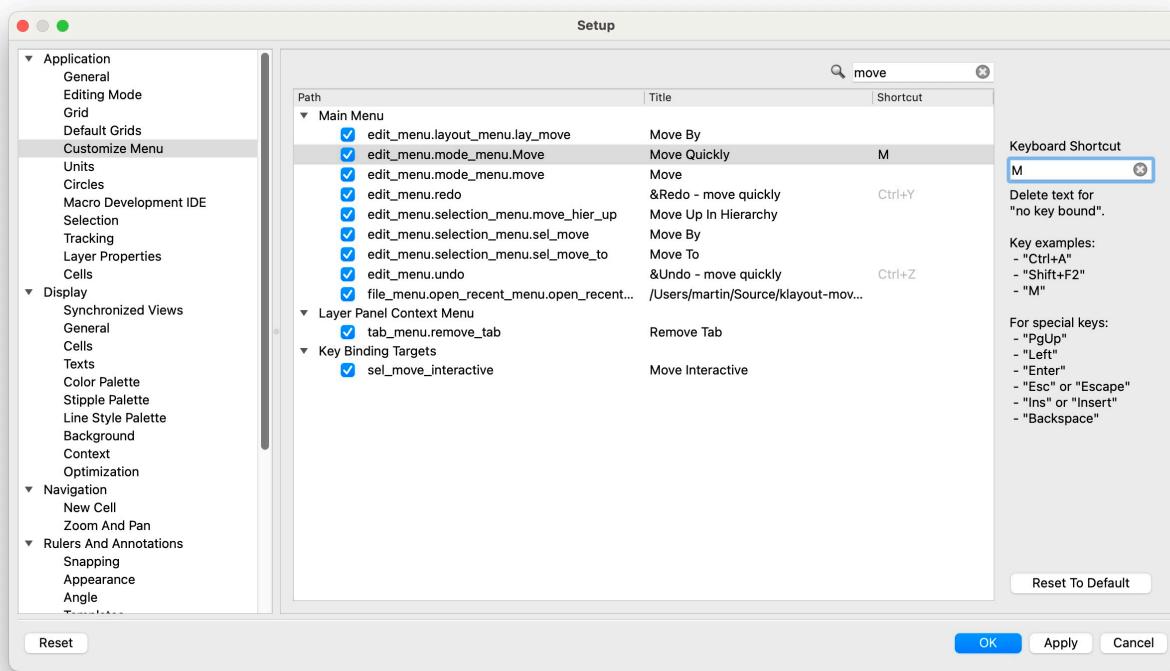


Figure 11: Assign key binding

4 Pin Tool

4.1 Motivation

Boost your layout productivity with quick placement of pins.

4.2 Usage

4.2.1 Placing a pin

The *Pin Tool* will automatically choose the appropriate layer based on the selection in the layer table.

E.g., if currently `TopMetal1.drawing` is selected (Figure 12), the layer `TopMetal1` will be chosen.

Before placing the pin, configure the desired properties in the dock setup panel (Figure 13):

- *Layer*: usually pre-filled with the appropriate layer, but can be changed here
- *Pin*: name of the pin label
- *Width / Height*: dimensions of the pin

To place a pin:

- Move the mouse to preview the pin placement (Figure 14)
 - A dashed box will indicate the bounds of the pin
 - A small circle will indicate the placement position
- Left-click to place a pin
- Press `Esc` to quit the tool

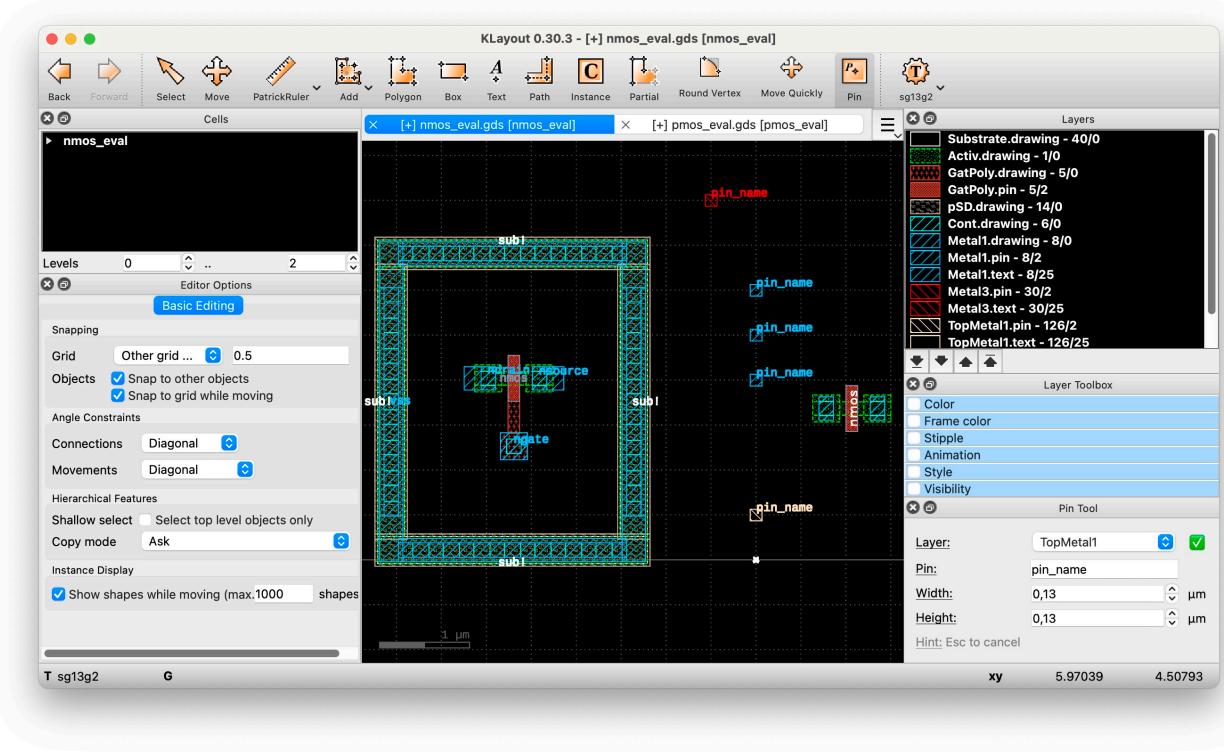


Figure 12: Pin Tool

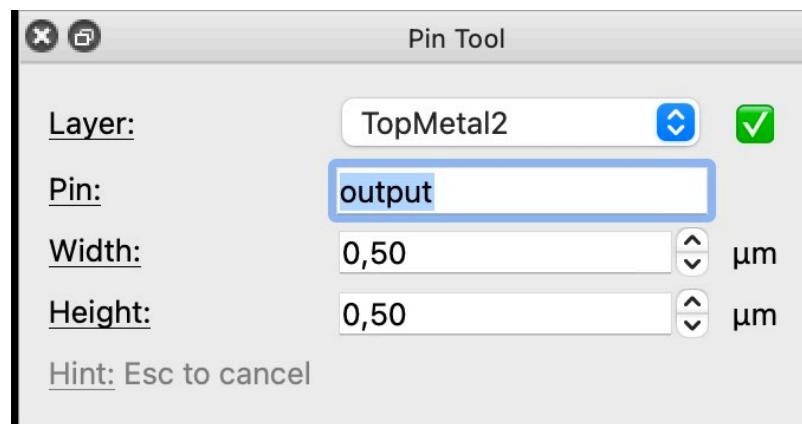


Figure 13: Dock Setup Panel

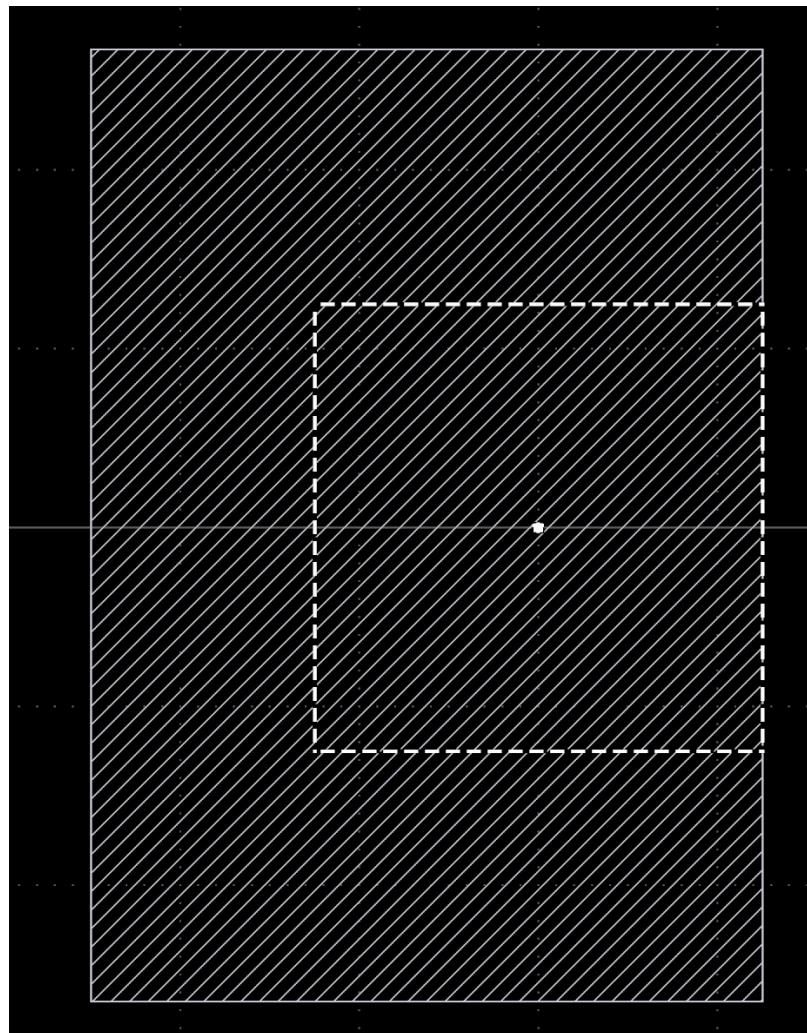


Figure 14: Pin Placement

4.2.2 Combined usage with the *Layer Shortcuts Plugin*

Say you want to place the same pin in multiple layers, there is a nice use case combination with the *Layer Shortcuts Plugin*:

- activate the *Pin Tool* and name the pin label
- press key 1 to focus on layer group **Metal1**
- place a pin in layer **Metal1**
- press key 2 to focus on layer group **Metal2**
- place a pin in layer **Metal2**
- press key 3 to show all layers

4.3 JSON tech files for supported PDKs

 Note

The JSON tech files are currently available for the PDKs:

- IHP SG13G2
- Skywater sky130

5 Layer Shortcuts Plugin

Boost your layout productivity with shortcuts to quickly change layer visibility and selection.

5.1 Usage

5.1.1 Tool activation and deactivation

Activate or deactivate the *Layer Shortcuts* plugin by selecting *Tools*→*Layer Shortcut Plugin* in the main menu.

5.1.2 Shortcuts

Shortcuts can be defined as action steps in the JSON configuration file.

This following table describes the shortcuts of our default IHP SG13G2 configuration.

| Shortcut | Description (What happens) |
|----------------|--|
| 0 | Show default layers |
| , | Hide default layers |
| 1 | Focus on 1st metal and related vias |
| 2 | Focus on 2nd metal and related vias |
| 3 | Focus on 3rd metal and related vias |
| 4 | Focus on 4th metal and related vias |
| 5 | Focus on 5th metal and related vias |
| 6 | Focus on 6th metal and related vias |
| 7 | Focus on 7th metal and related vias |
| 8 | Focus on Gate Poly and related layers |
| 9 | Focus on Diffusion and related layers |
| Shift+1 | Extend the focus to include 1st metal and related vias |
| Shift+2 | Extend the focus to include 2nd metal and related vias |
| Shift+3 | Extend the focus to include 3rd metal and related vias |
| Shift+4 | Extend the focus to include 4th metal and related vias |
| Shift+5 | Extend the focus to include 5th metal and related vias |
| Shift+6 | Extend the focus to include 6th metal and related vias |
| Shift+7 | Extend the focus to include 7th metal and related vias |
| Shift+8 | Extend the focus to include Gate Poly and related vias |
| Shift+9 | Extend the focus to include Diffusion and related vias |

5.2 Supported PDKs

Currently, we support the following PDKs:

- IHP SG13G2: <https://github.com/iic-jku/klayout-layer-shortcuts/blob/main/pdks/ihp-sg13g2.json>
- Skywater sky130: <https://github.com/iic-jku/klayout-layer-shortcuts/blob/main/pdks/sky130.json>
- Global Foundries gf180mcu: <https://github.com/iic-jku/klayout-layer-shortcuts/blob/main/pdks/gf180mcu>

You can add support for additional PDKs by writing a JSON configuration file:

- copy [the existing JSON file](#) and ensure the PDK name is volare/ceil compatible
- Notes about the JSON file format

- NOTE: Layer names must be the same as in the KLayout layer properties XML file
(e.g. `~/.volare/ihp-sg13g2/libs.tech/klayout/tech/sg13g2.lyp`)
 - NOTE: The technology name must be the same as in the KLayout technology XML file
(e.g. `~/.volare/ihp-sg13g2/libs.tech/klayout/tech/sg13g2.lyt`)
 - NOTE: The layer group names must be unique but are completely custom
- [create a pull request](#)

6 Library Manager

Boost your layout productivity with hierarchical layouts:

- Automatically load cell libraries along with your hierarchical layout
- Manage loaded cell libraries
- Reload updated cells
- Export the final layout for tapeout

6.1 Usage

6.1.1 Basics

- Hierarchical layouts have suffix `*.klay` (and are technically OASIS files with special metadata)
- A library is just a Layout, with its top cells representing library cells
- Library maps have suffix `*.klib` (and are basically JSON files with a special schema), they can contain
 1. Comments
 2. Library Definition: maps a name to a library path (e.g. a stdcell library)
 3. Library Map Includes: reference to include another `*.klib` file (e.g. a set of libraries useful for the PDK)
- **NOTE:** alternatively to this plugin, you could also put them in `~/.klayout/libraries/`

6.1.2 Menu Commands

1. In the *File* Menu, there are commands related to the library manager (Figure 15)
2. Use *File*→*New Hierarchical Layout...* to configure a new hierarchical layout (Figure 16)
3. With a Hierarchical Layout open, use *File*→*Manage Cell Library Map...* to manage the cell libraries (Figure 17)
4. The loaded cell libraries will appear in the Libraries Panel (Figure 18)
5. With a Hierarchical Layout open, use *File*→*Save Hierarchical Layout [As]...* to save the layout.
6. Finally, use *File*→*Export Layout For Tapeout...* to export the final layout version for tapeout.

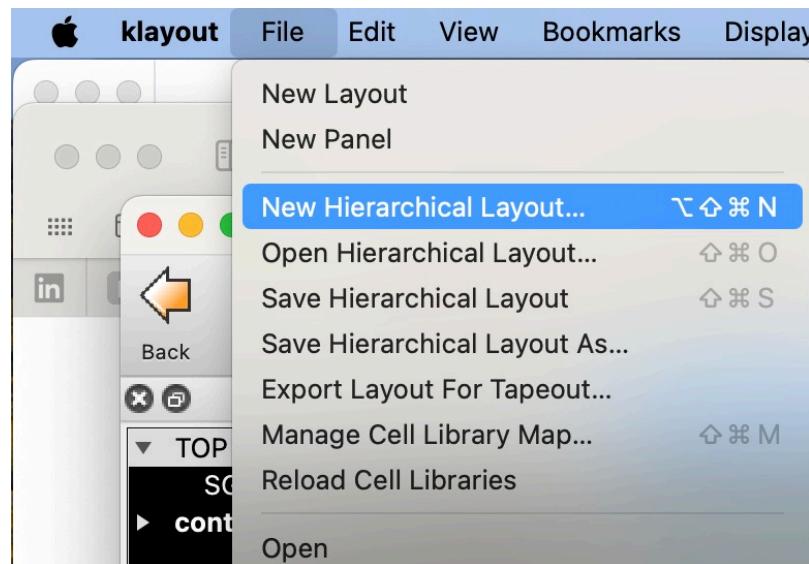


Figure 15: Menu commands related to the KLayout Library Manager

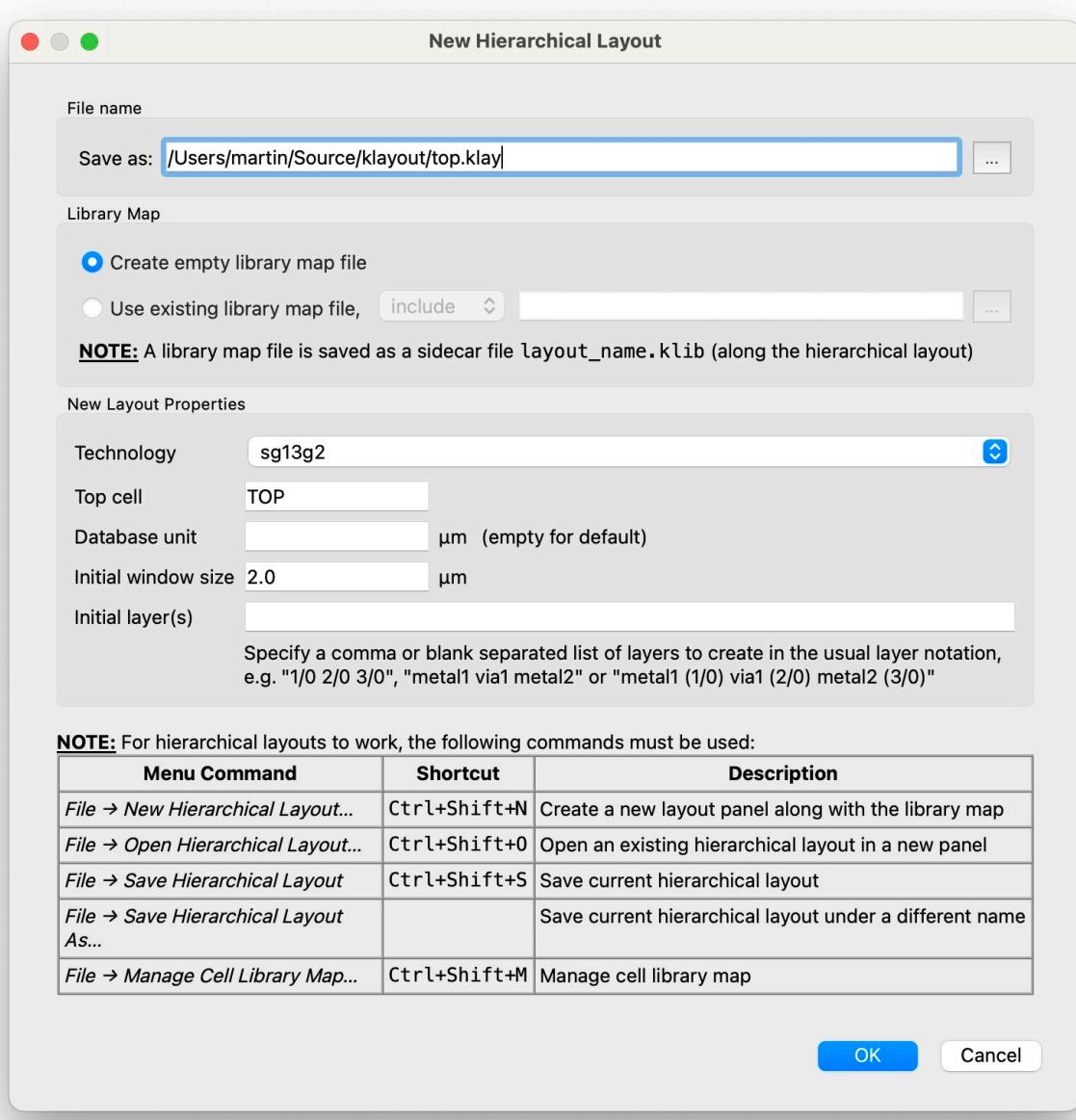


Figure 16: Create New Hierarchical Layout

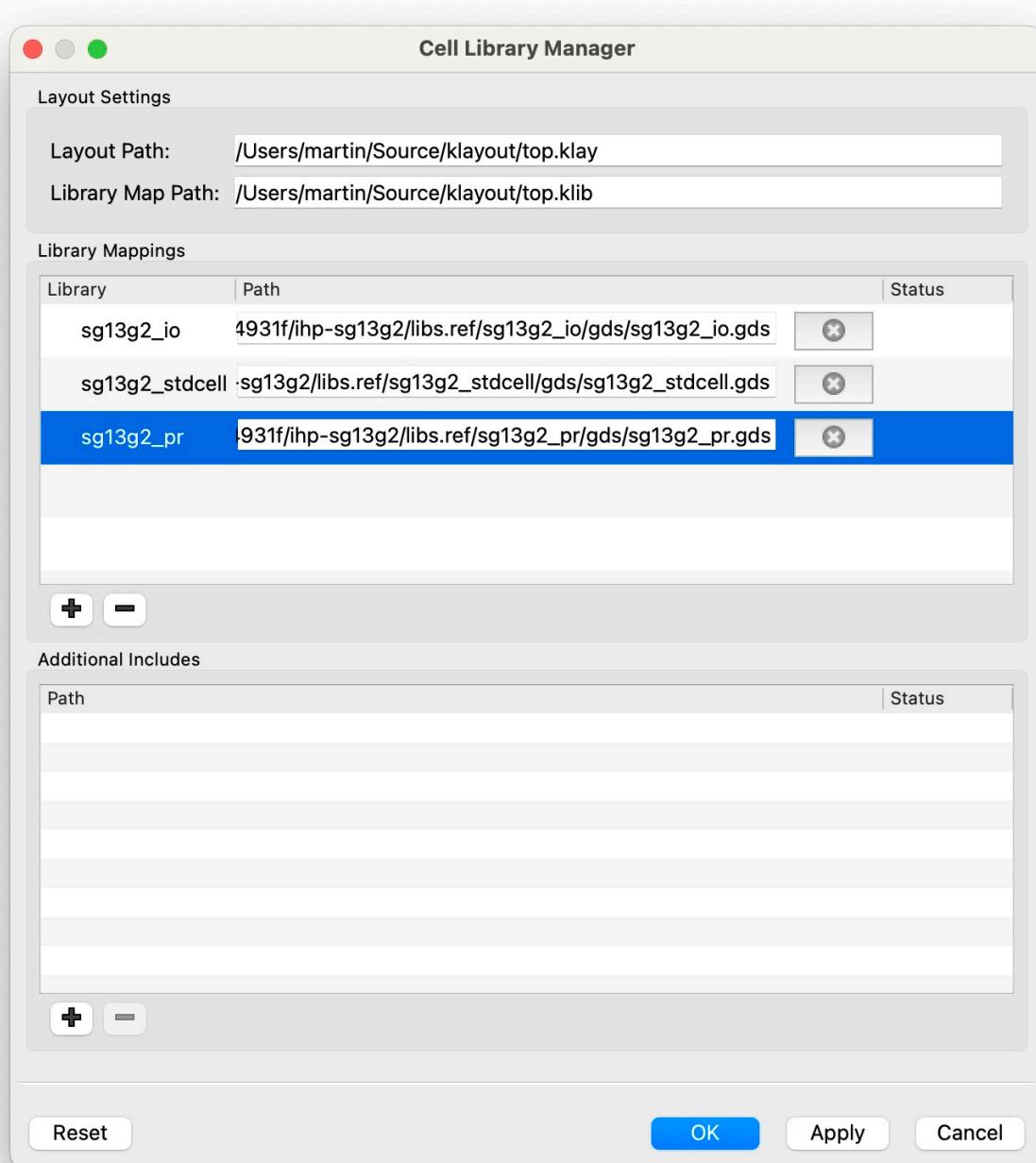


Figure 17: Manage Cell Libraries

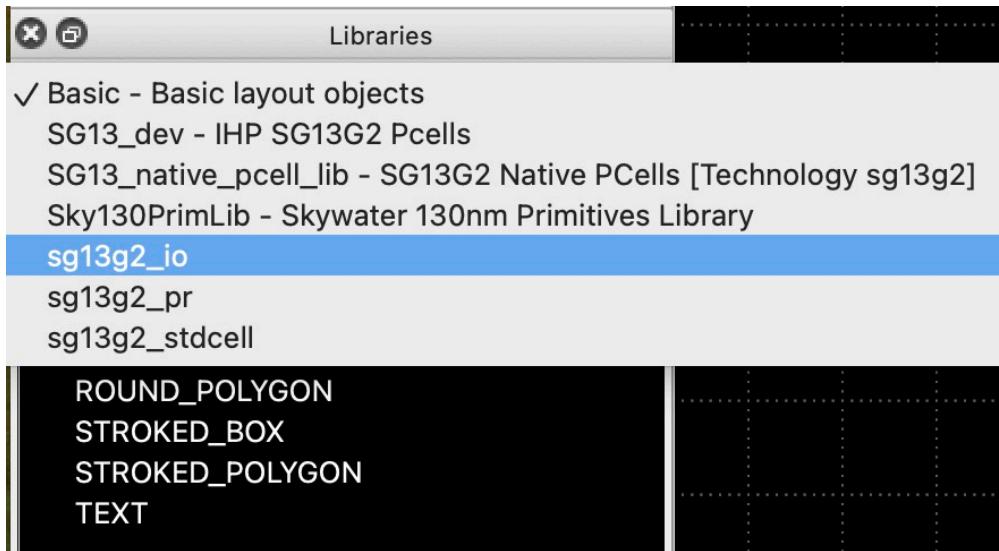


Figure 18: Loaded Cell Libraries

7 Automatic Backups

This plugin automatically creates backups

- Save your precious layout work in case of crashes or power outages
- Configure intervals and rotation scheme

7.1 Usage

7.1.1 Tool activation and deactivation

Activate or deactivate the *Auto Backup* plugin by selecting *File*→*Automatic Backups*→*Enable Automatic Backups* in the main menu.

Configure backup settings by clicking *File*→*Automatic Backups*→*Setup Automatic Backups* in the main menu.

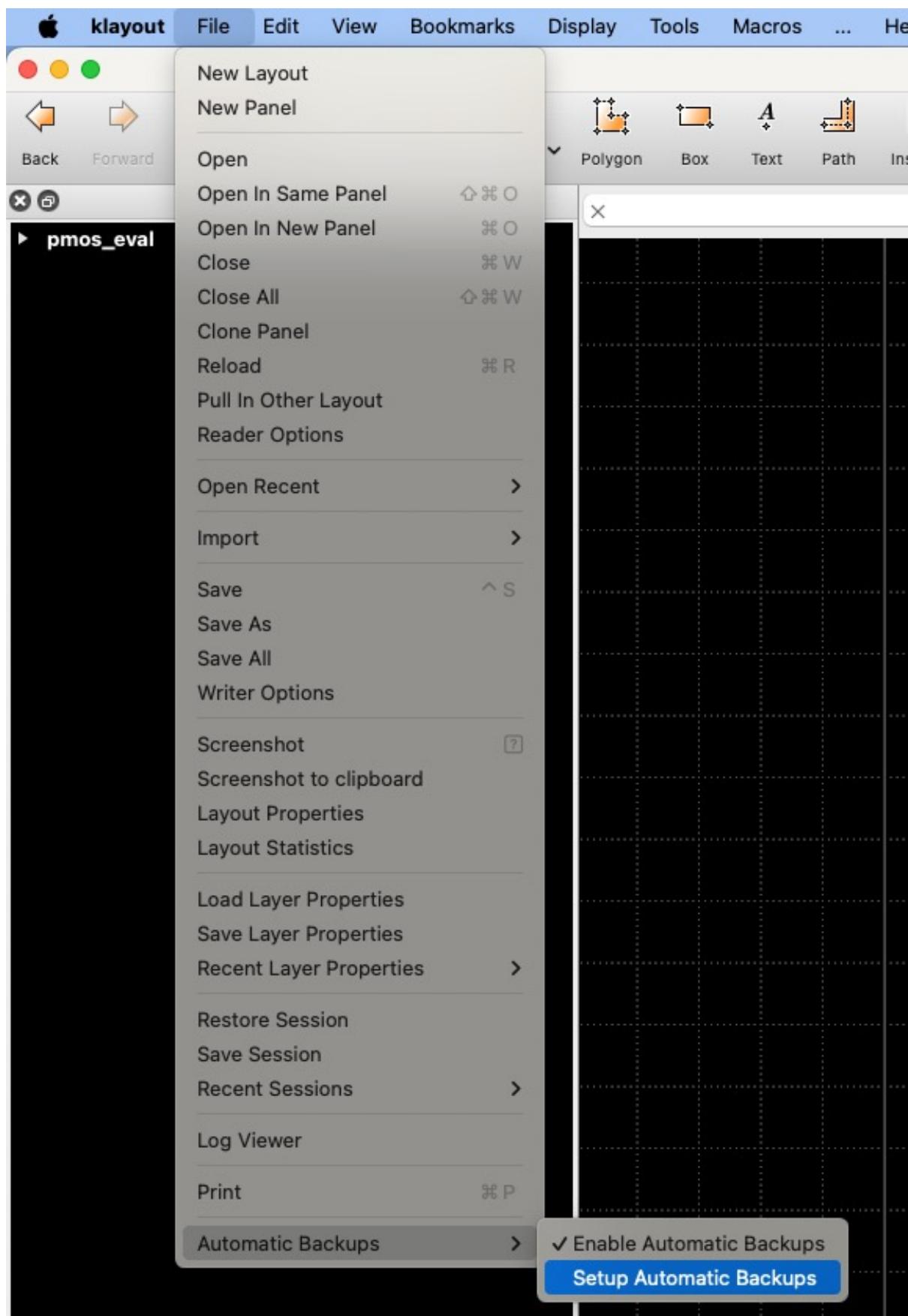


Figure 19: Menu File → Automatic Backups

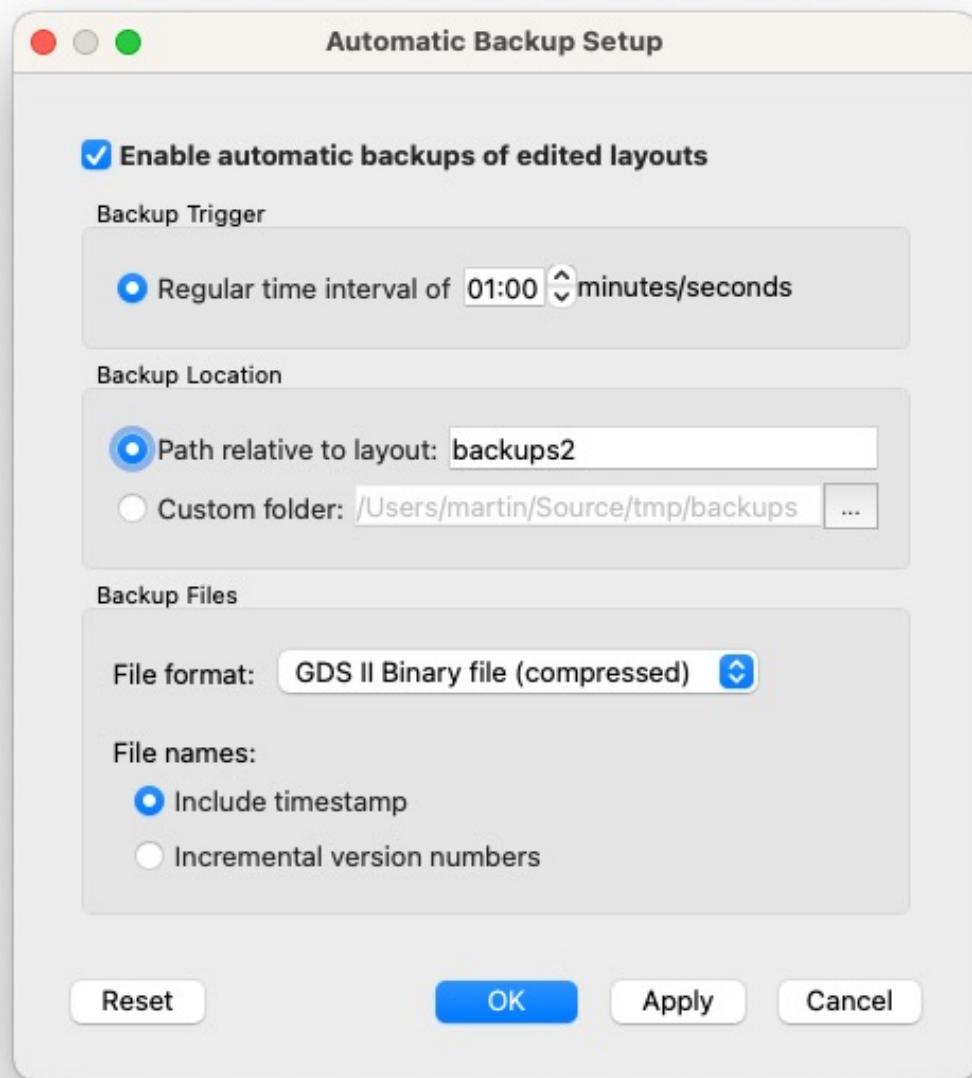


Figure 20: Setup Automatic Backups