

KLayout Productivity Suite Documentation

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2025-12-04

Table of contents

1	Introduction	1
1.1	About KLayout Productivity Suite	1
1.2	Acknowledgements	2
1.3	Installation	2
1.3.1	Option 1: Using IIC-OSIC-TOOLS Docker Image	2
1.3.2	Option 2: Standalone Installation	2
2	Align Tool	4
2.1	Motivation	4
2.2	Usage	4
2.2.1	Pre-Selection	4
2.2.2	Selecting Features	5
2.2.3	Example 1: point-to-point alignment	5
2.2.4	Example 2: edge-to-edge alignment	5
2.3	Assign key binding A to the tool	10
3	Move Quickly Tool	11
3.1	Usage	11
3.1.1	Pre-selection	11
3.1.2	Tool activation and deactivation	11
3.1.3	Example 1: Moving single object (mouse)	11
3.1.4	Example 2: Moving single object (keyboard)	12
3.1.5	Example 3: Extend selection	12
3.1.6	Example 4: Drag selection	12
3.2	Pro-Tip: assign key binding M to the tool	12
4	Pin Tool	13
4.1	Motivation	13
4.2	Usage	13
4.2.1	Placing a pin	13
4.2.2	Combined usage with the <i>Layer Shortcuts Plugin</i>	16
4.3	JSON tech files for supported PDKs	16
5	Layer Shortcuts Plugin	17
5.1	Usage	17
5.1.1	Tool activation and deactivation	17
5.1.2	Shortcuts	17
5.2	Supported PDKs	17

6 Library Manager	19
6.1 Usage	19
6.1.1 Basics	19
6.1.2 Menu Commands	19
7 Automatic Backups	22
7.1 Usage	22
7.1.1 Tool activation and deactivation	22

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**...

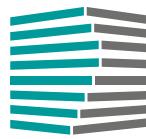
1.2 Acknowledgements

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



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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

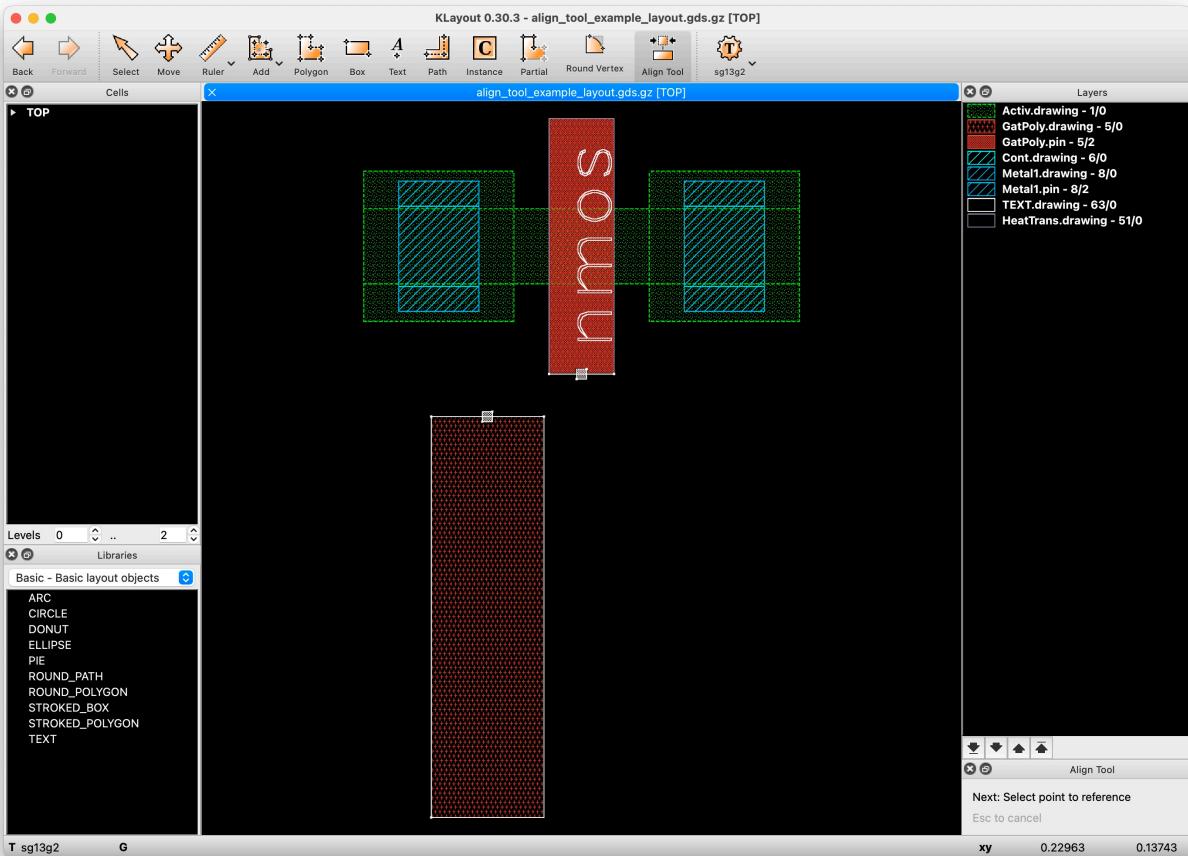


Figure 3: Align Tool

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

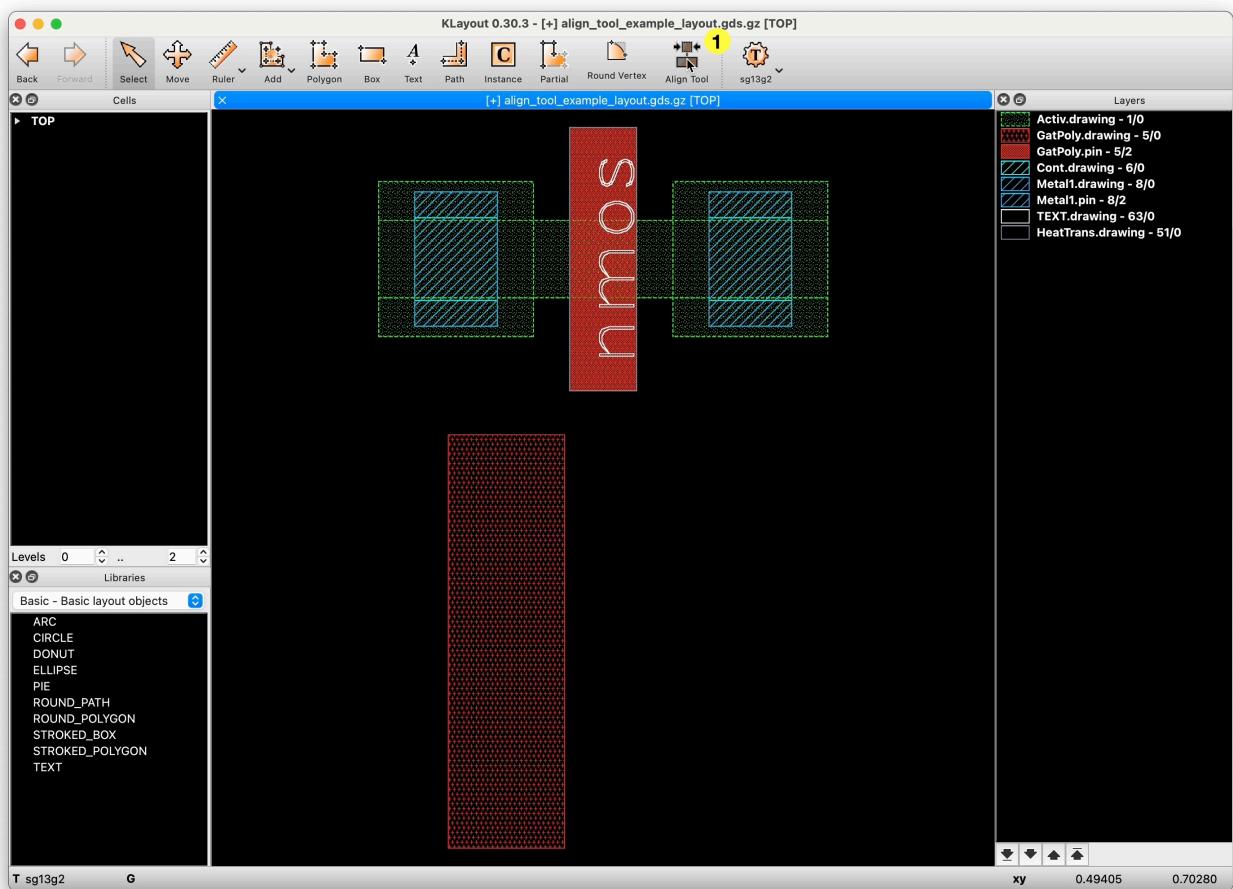


Figure 5: Select Align Tool

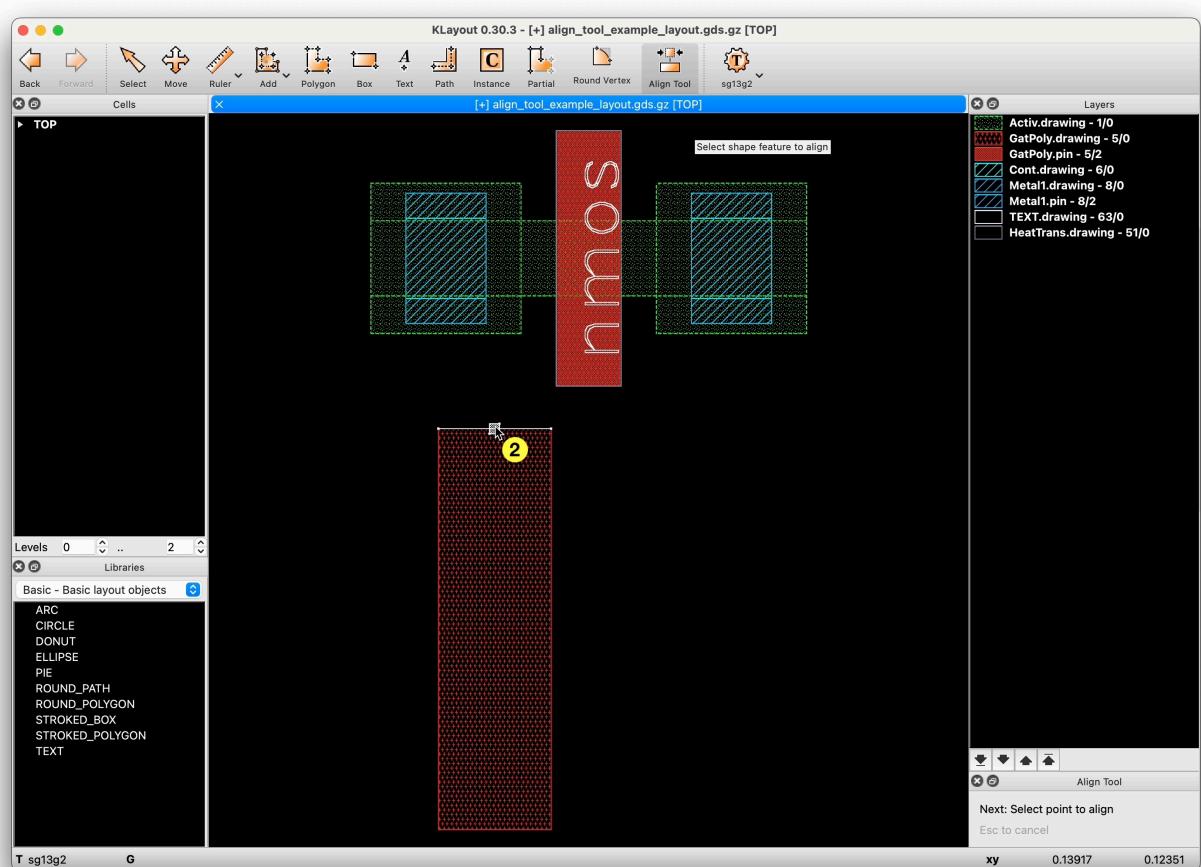


Figure 6: Select *source reference* point to align

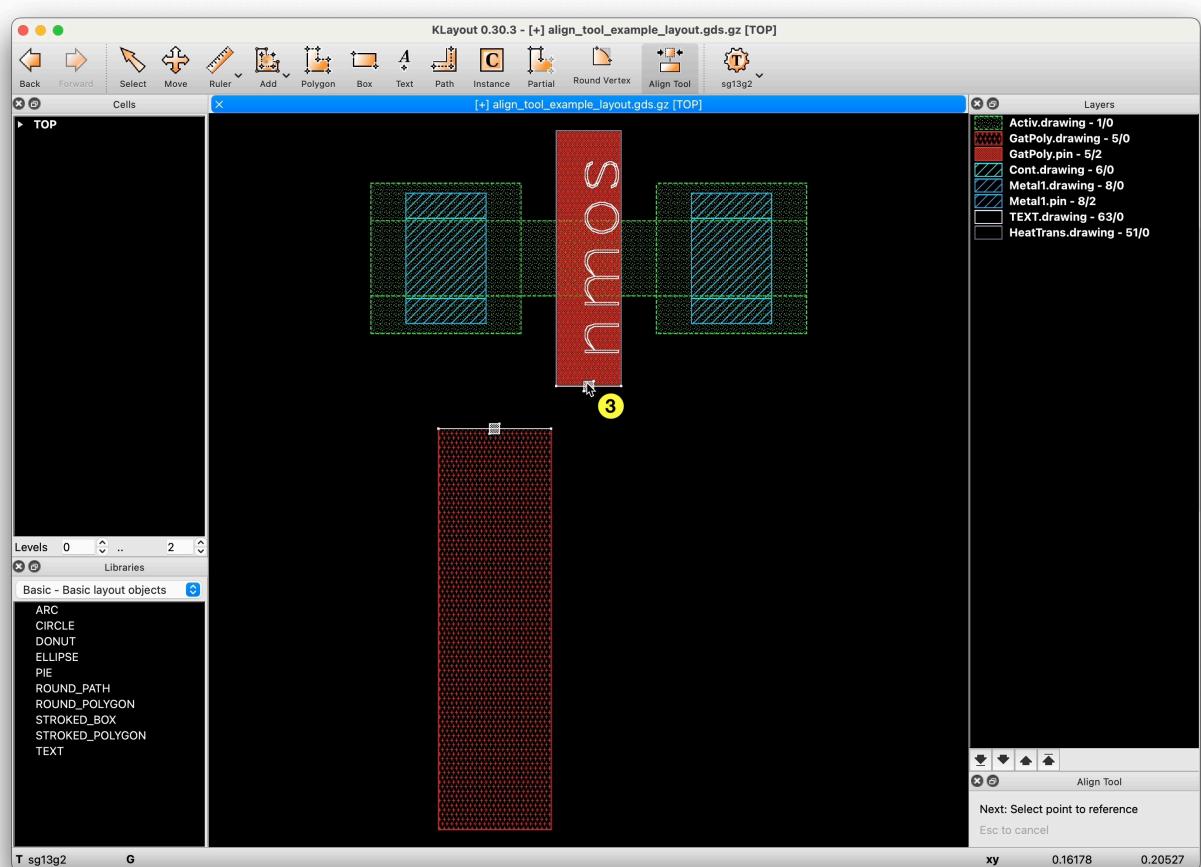


Figure 7: Select *target reference point* to move to

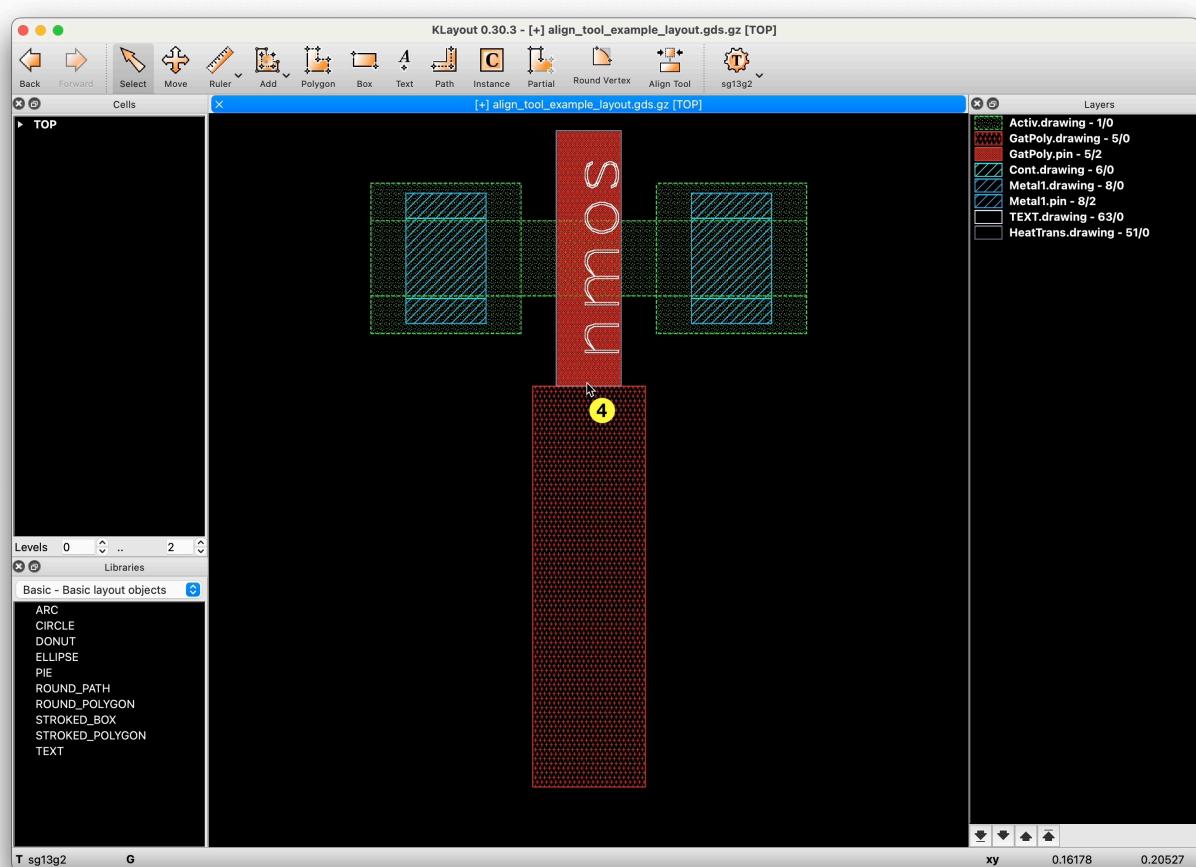


Figure 8: Alignment done

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`

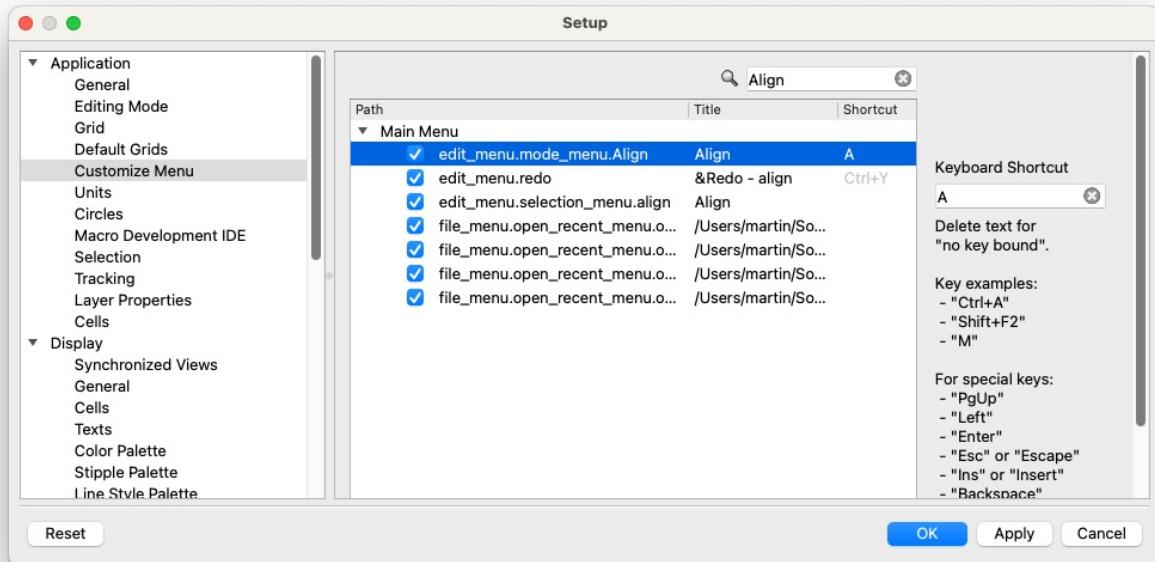


Figure 9: Assign key binding

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

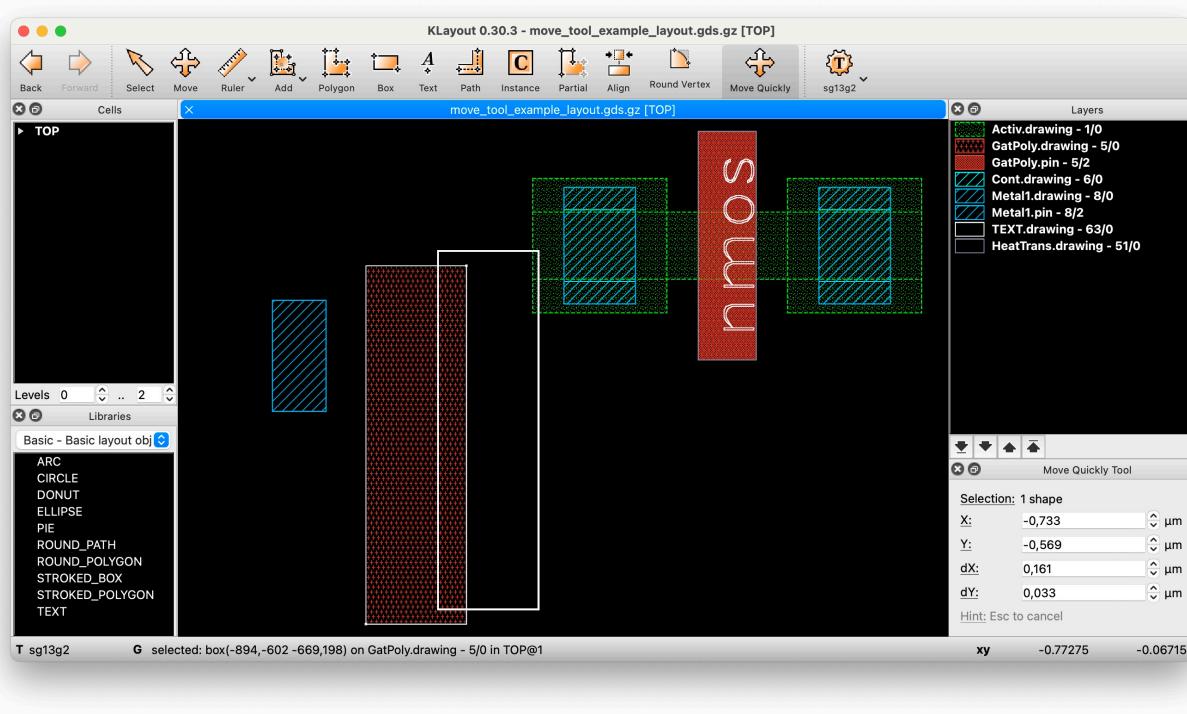


Figure 10: Move Quickly Tool

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`

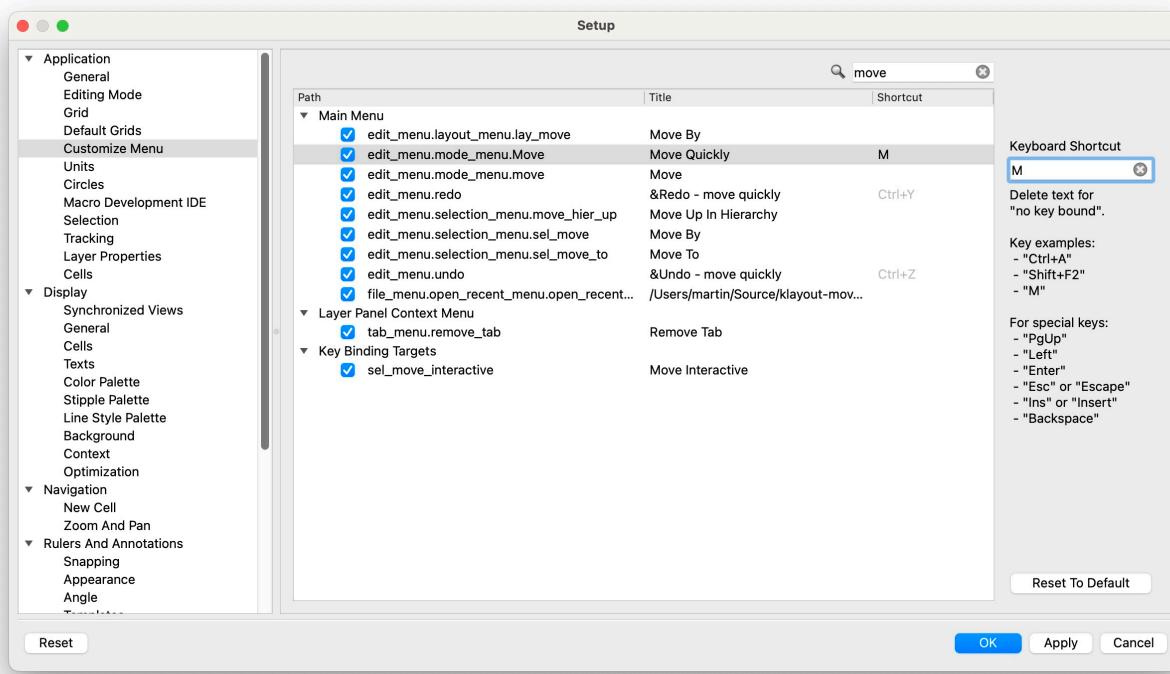


Figure 11: Assign key binding

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

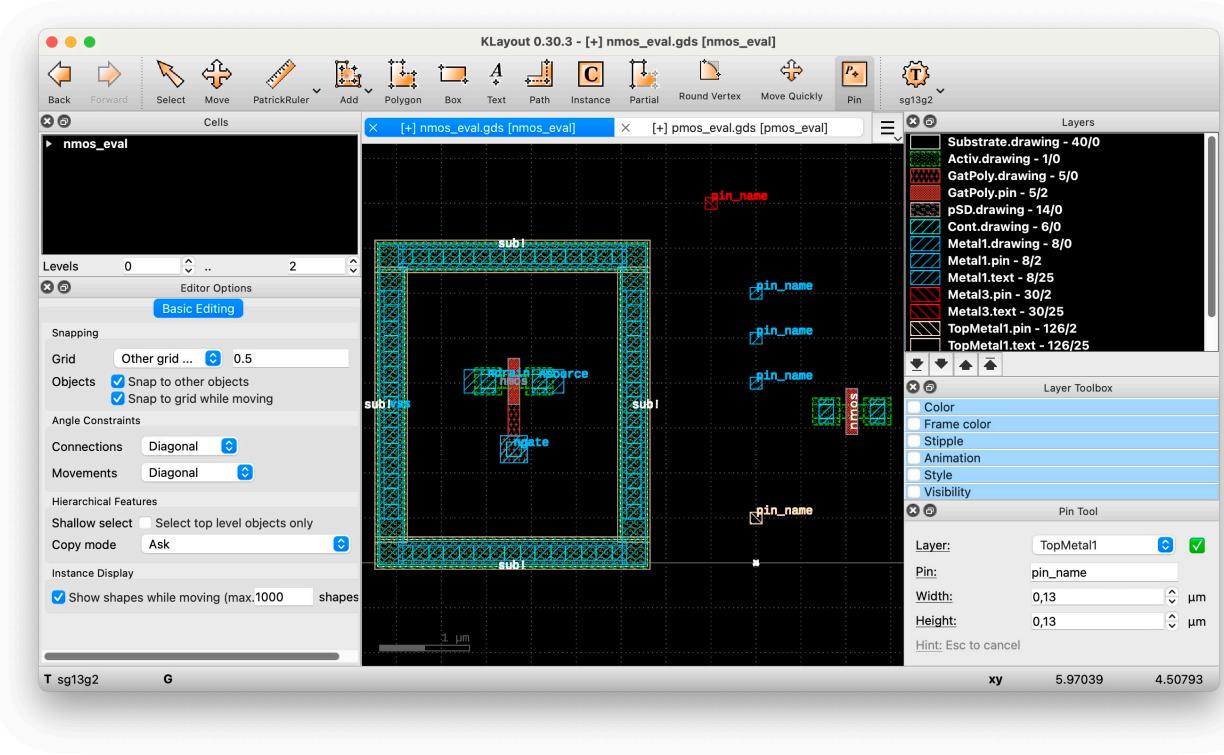


Figure 12: Pin Tool

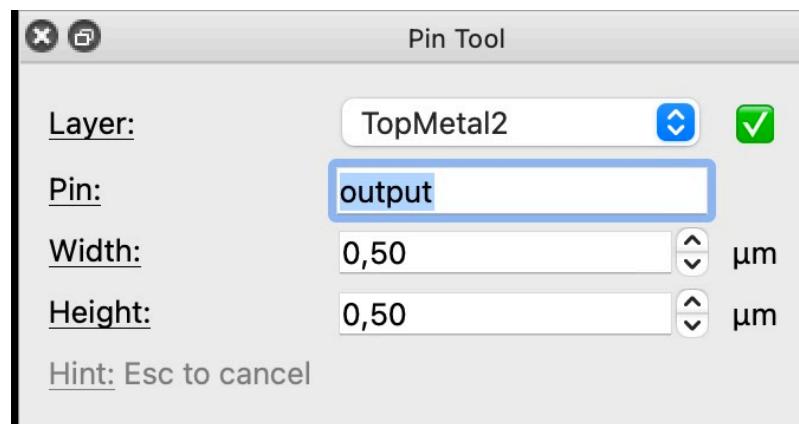


Figure 13: Dock Setup Panel

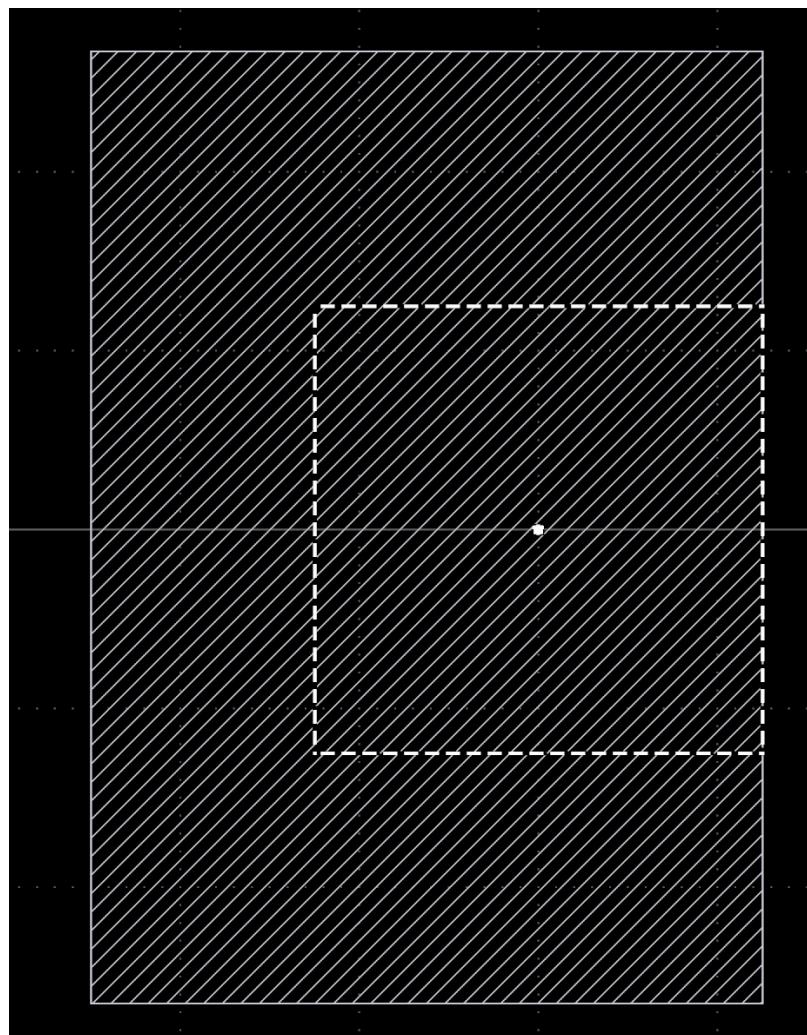


Figure 14: Pin Placement

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.

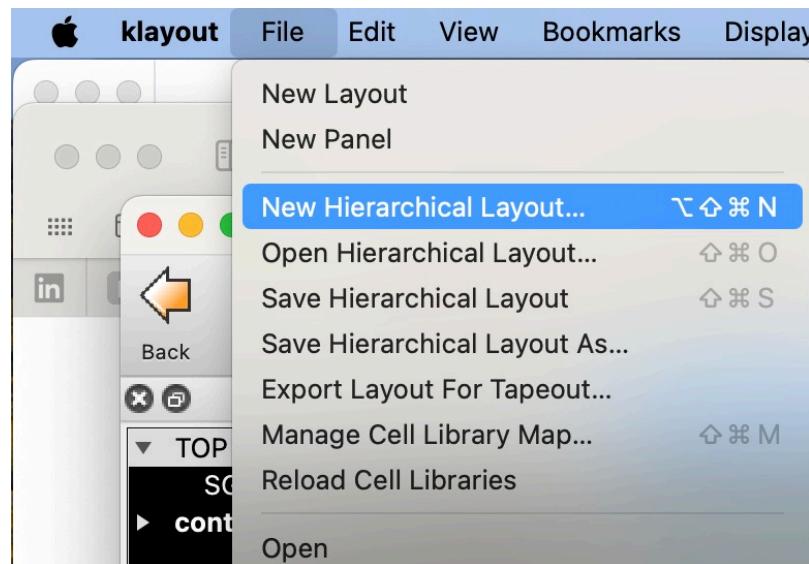


Figure 15: Menu commands related to the KLayout Library Manager

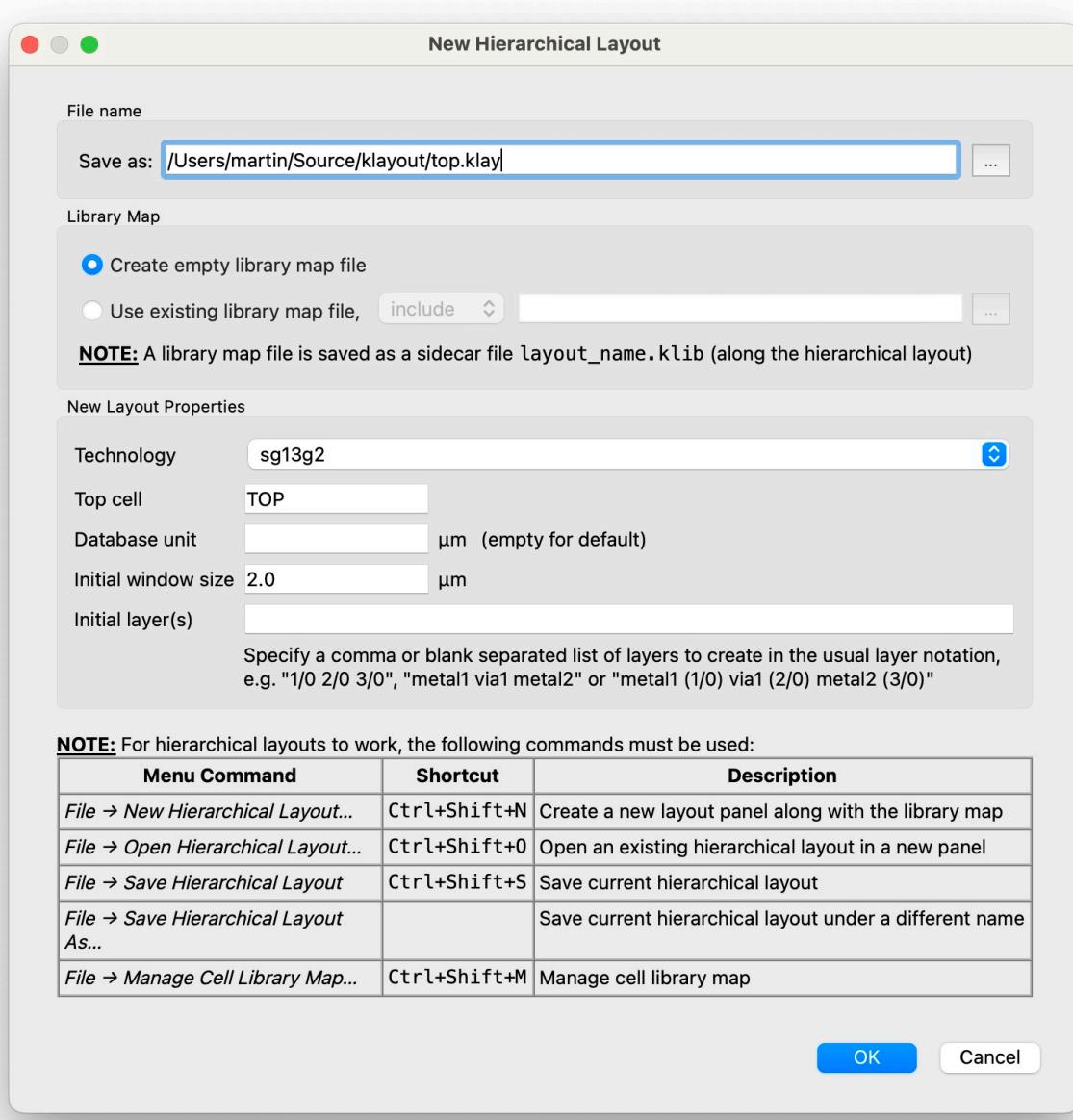


Figure 16: Create New Hierarchical Layout

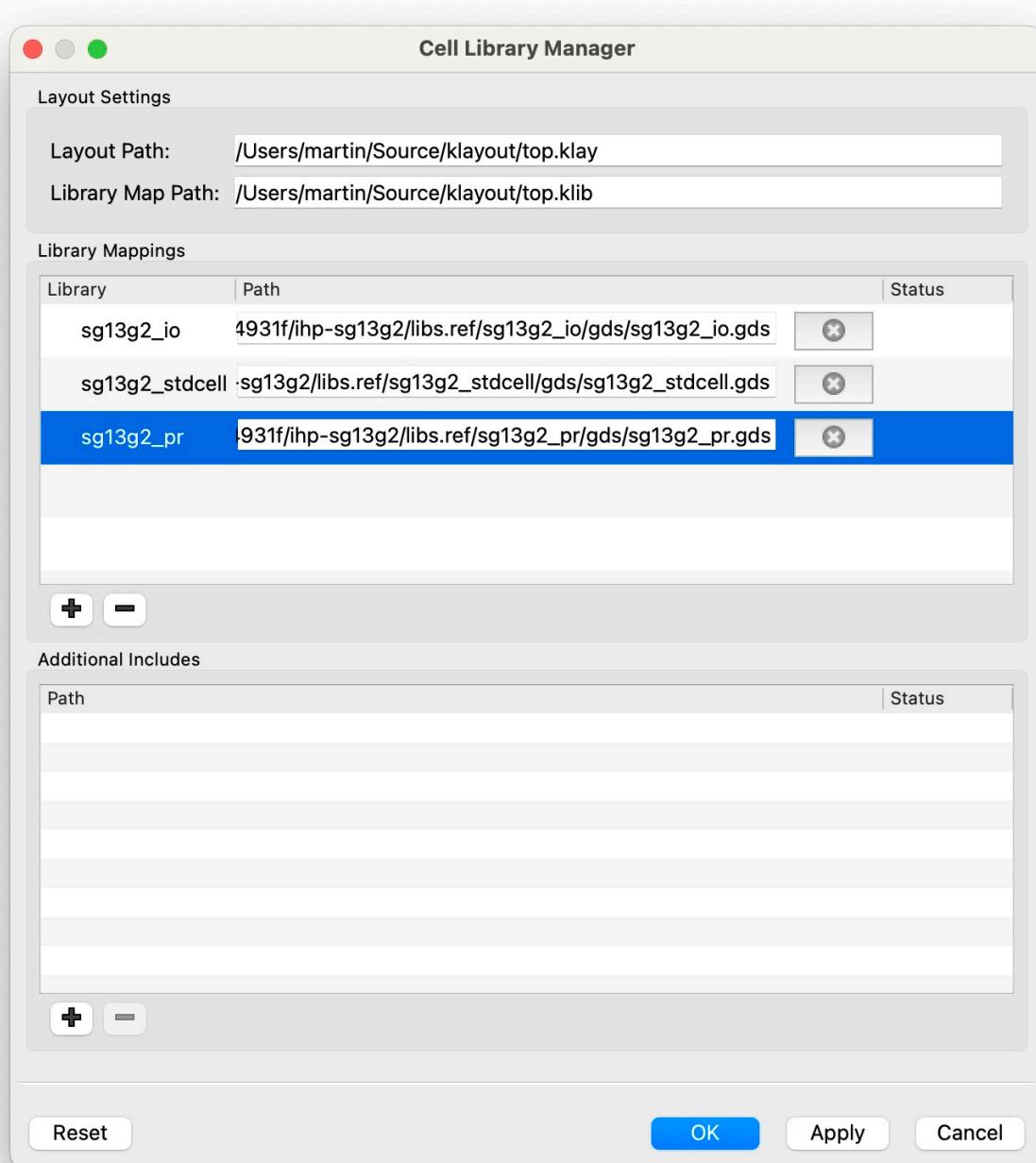


Figure 17: Manage Cell Libraries

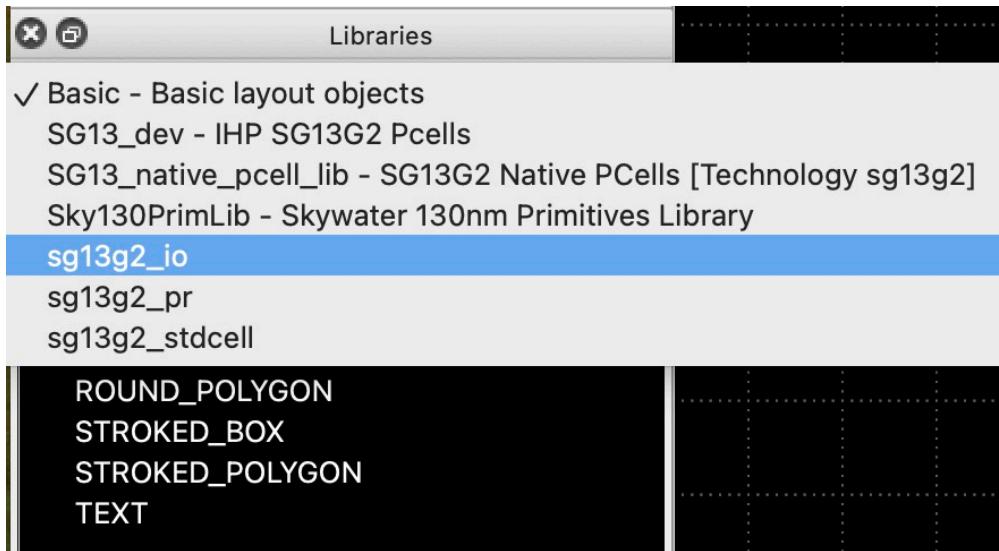


Figure 18: Loaded Cell Libraries

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.

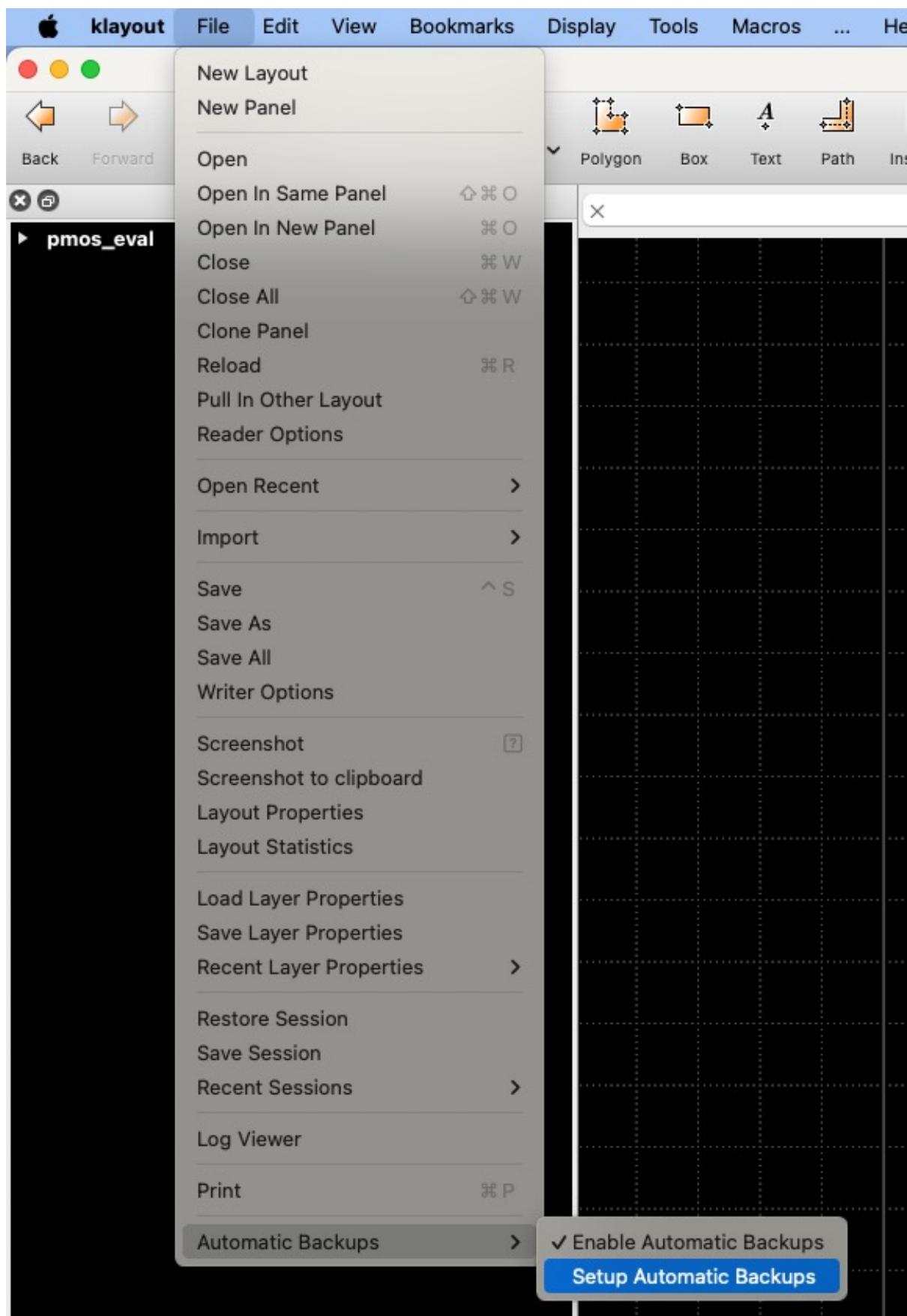


Figure 19: Menu File → Automatic Backups

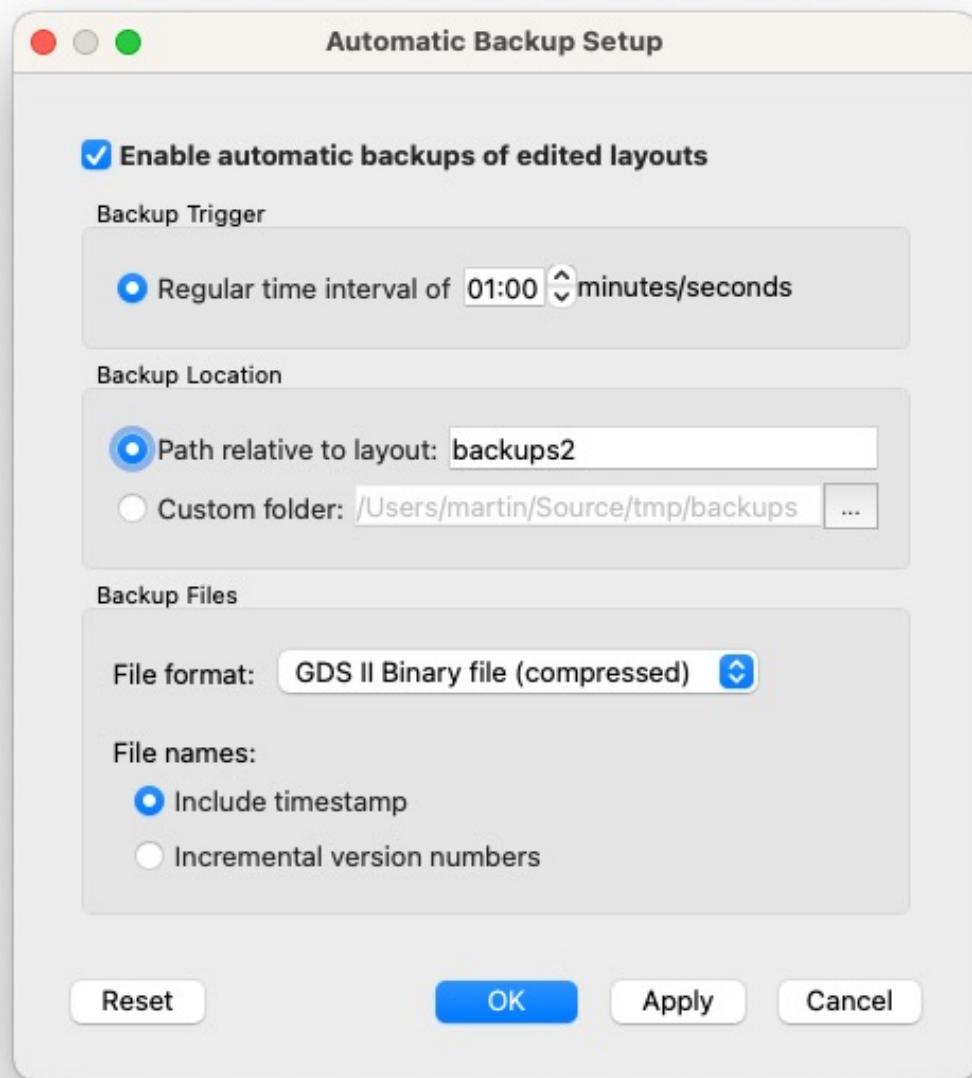


Figure 20: Setup Automatic Backups