

2D Mask Layout Editor

User Guide

Team 1: Software Tool Development for Physical Layout Visualization

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Contents

1	Introduction	3
1.1	Key Features	3
2	Getting Started	3
2.1	The Welcome Screen	3
2.2	The Main Interface	3
3	Core Concepts	4
3.1	Hierarchy: Cells and References	4
3.2	Layers	4
4	Drawing and Editing	4
4.1	Navigation	4
4.2	Drawing Basic Shapes	5
4.3	Selecting and Moving Objects	5
4.4	Editing and Modifying Shapes	5
5	Managing Your Project	5
5.1	Working with Cells	5
5.2	Working with Layers	5
6	The Interactive 3D Preview	6
7	File Management	6
8	Shortcuts & Hotkeys	6

1 Introduction

The 2D Mask Layout Editor is a vector graphics tool designed for creating hierarchical 2D designs, often used for things like semiconductor masks, MEMS devices, printed circuit boards (PCBs), or any other application that requires precise, layered geometry.

Its core strength lies in its **hierarchical design philosophy**. Instead of drawing everything as a flat image, you create reusable building blocks called **Cells**. You can then place these cells within other cells, allowing you to build complex designs from simple, manageable components.

1.1 Key Features

- **Hierarchical Structure:** Build complex layouts using reusable Cells and References.
- **Layer-Based Organization:** Assign objects to different layers for easy visibility control and organization.
- **Precise Drawing Tools:** Create rectangles, circles, polygons, and paths with grid snapping.
- **Advanced Editing:** Perform transformations (rotate, scale, flip), filleting, and powerful boolean operations (union, subtract, intersect).
- **Industry-Standard Formats:** Import and export GDSII (`.gds`) and OASIS (`.oas`) files.
- **Interactive 3D Preview:** Extrude your 2D layers into a 3D stacked view to visualize the final structure.
- **Intuitive Interface:** A modern, dock-based UI with a ribbon-style toolbar and helpful shortcuts.

2 Getting Started

2.1 The Welcome Screen

When you first launch the application, you'll be greeted by a welcome screen. You have two choices:

1. **Create New Project:** Starts a blank project. You'll be asked to configure the grid and canvas size.
2. **Open Existing File:** Lets you browse for a project file. The editor can open its native `.json` format as well as import `.gds` and `.oas` files.

2.2 The Main Interface

Once a project is open, you'll see the main editor window.

It's composed of several key areas:

1. **Ribbon Toolbar (Top):** Your command center, organized into tabs (**Main**, **Draw**, **View**).
2. **Cells Panel (Left):** Lists all the "design blueprints" (Cells) in your project.
3. **Canvas (Center):** The main drawing area, with rulers for positioning.
4. **Layers Panel (Right):** Lists all layers for controlling visibility, color, and drawing order.
5. **Status Bar (Bottom):** Displays cursor coordinates and status messages.

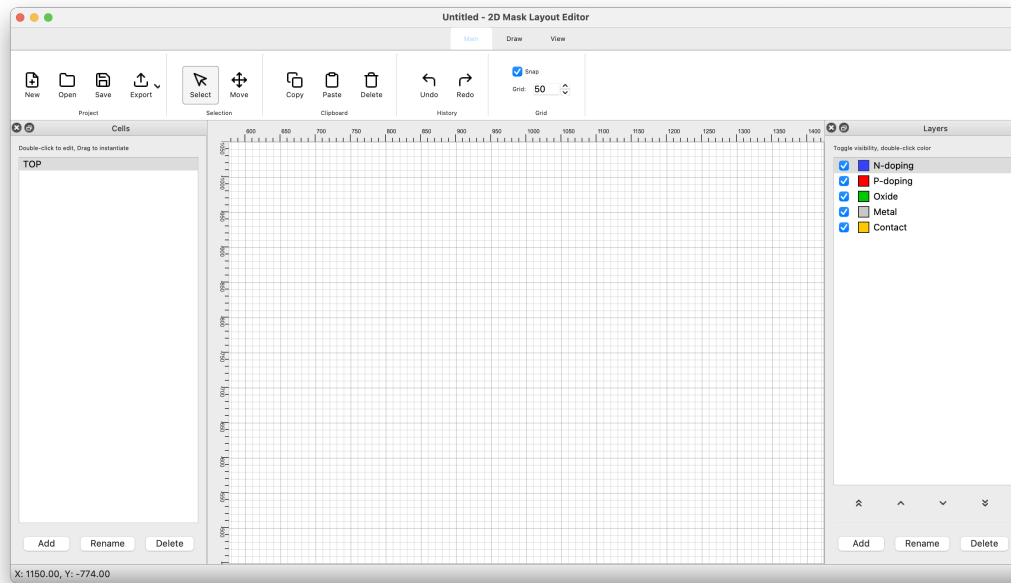


Figure 1: The main interface of the 2D Mask Layout Editor.

3 Core Concepts

3.1 Hierarchy: Cells and References

Cell: A **blueprint** or a template. For example, a cell named `TRANSISTOR` could contain all the polygons for the gate, source, and drain.

Reference (or Instance): A **placement** of a cell within another cell. It has its own origin, rotation, and magnification. If you need to change the transistor design, you only need to edit the `TRANSISTOR` cell once, and all references will update automatically.

3.2 Layers

Layers are like transparent sheets stacked on top of each other.

- **Organization:** Used to separate different parts of your design (e.g., "Metal 1", "N-doping").
- **Visualization:** Show or hide layers to focus on specific parts. The color of each layer helps you visually distinguish between components.
- **Drawing Order:** The order of layers in the Layers Panel matters. Layers at the **bottom of the list are drawn first**, and layers at the top are drawn last (on top of the others).

4 Drawing and Editing

4.1 Navigation

Pan: Click and drag with the **middle mouse button**.

Zoom: Use the **mouse scroll wheel**.

Fit View: Press **F** to automatically zoom to fit all shapes.

4.2 Drawing Basic Shapes

Rectangle (R): Click and drag to define the corners.

Circle (C): Click and drag to define the bounding box.

Polygon (P): Click to place each vertex. **Double-click the left mouse button** to finish the shape.

Path/Wire (W): Click to place each vertex of the centerline. **Double-click** to finish, then enter a width. (Requires *gdstk* library).

To cancel any drawing operation, press the **Esc** key.

4.3 Selecting and Moving Objects

Select Tool (S): Click an object to select it. Hold **Shift** to select multiple. Drag a box to select all objects inside.

Move Tool (M): Click and drag any selected object to move it.

4.4 Editing and Modifying Shapes

- **Properties:** **Double-click** any shape to open a dialog for precise numerical entry.
- **Transform:** Rotate, Scale, or Flip the selection around its center.
- **Arrange:** Change the drawing Z-order of shapes within the same cell (Bring to Front, Send to Back, etc.).
- **Fillet:** Rounds the corners of a selected polygon. (Requires *gdstk*).
- **Boolean Operations:** Combine two or more shapes with Union, Subtract, or Intersect. (Requires *gdstk*).

5 Managing Your Project

5.1 Working with Cells

- **View a Cell:** **Double-click** a cell's name in the list to open it for editing.
- **Instantiate a Cell:** **Drag a cell from the list and drop it onto the canvas** to create a reference.
- **Pro Tip:** Drop a cell onto an existing shape to automatically scale and place the reference, replacing the shape.

5.2 Working with Layers

- **Set Active Layer:** Click a layer name to make it active for new drawings.
- **Visibility:** Check or uncheck the box to show or hide a layer.
- **Change Color:** **Double-click** the color swatch.
- **Reorder Layers:** Use the arrow buttons to change the drawing order.

6 The Interactive 3D Preview

Found under the **View** tab, this tool extrudes your 2D layout into a 3D model.

- **Navigation:** Rotate with the left mouse button, zoom with the scroll wheel.
- **Controls:** Use sliders to adjust layer thickness in real-time. Buttons are available for standard views (Isometric, Top, etc.) and saving an image.

7 File Management

- **Save/Save As:** Saves the project in the native `.json` format.
- **Export:**
 - **GDS/OAS:** Saves in industry-standard formats. A `.json` sidecar file is also created to store layer metadata (names, colors).
 - **SVG:** Exports the current view as a Scalable Vector Graphic.

8 Shortcuts & Hotkeys

Action	Shortcut
New Project	Ctrl+N
Open File	Ctrl+O
Save	Ctrl+S
Undo / Redo	Ctrl+Z / Ctrl+Y
Copy / Paste / Delete	Ctrl+C / Ctrl+V / Del
Select All	Ctrl+A
Fit to View	F
Zoom In / Zoom Out	Ctrl+= / Ctrl+-
Select / Move Tool	S / M
Rectangle / Polygon Tool	R / P
Circle / Path Tool	C / W
Cancel Drawing	Esc