

Photomask Design Using L-Edit Pro

1. Overview

This manual provides a quick tutorial on the procedure to obtaining a set of masks using L-Edit Pro program. For more detailed information on L-Edit, please use **Help** within the program.

2. L-Edit Quick Reference

2.1. How to Access the L-Edit Program:

The L-Edit program is situated in the “Mask Design Computer” in J-wing atrium of the Engineering Quadrangle building. To obtain password to the computer please contact Helena Gleskova or Joe Palmer. To access the program click on the **L-Edit v 10.20** icon located on the desktop of the computer.

2.2. Before Starting ... useful definitions:

Technology

A technology is the equivalent of one layer in a mask design. L-Edit supports an unlimited number of technology layers. These are displayed in the layer palette as an arrangement of square icons that represents the available layers. The icons are differentiated by color and pattern.

2.3. The Program Layout:

The program layout contains three distinct areas. The first area is known as the work area. This is the grayish-colored central region where mask designs are constructed. It is best to think of the work area as a large sheet of paper. The second area is the menu bar. This is located at the very top of the program screen. It provides access to all of the major features of the program, including view control and special options such as the design rule checker. The third and last area consists of the toolbars. These include the standard toolbar for basic operations, the drawing toolbar for creating the mask design, the layer palette for selecting the appropriate layer in the mask design, and the locator to help determine the desired location of objects within the work area. (To view all the layers in the layer palette, make sure to scroll left in the toolbar).

2.4. The Program Settings:

The current default in the L-Edit program differs from the one that the program initially decided to implement. Both contain the same toolbars and overall layout; however, the new default has been modified so that somebody completely new to the program might be able to design and develop new photomasks in very little time.

Let us start out with the menu bar. Click on the word **View**. As one can see, a series of check marks runs down the options. To make sure nothing is kept out of view while creating a new layout, check to see if the following options are selected in **Display: icon, arrays, ports, grid, origin, and mouse hints**. Also, under **View > Status Bars** all bars

should be selected. If, for any reason, the options become difficult to work with, they can be turned off simply by selecting the option.

*** This next paragraph is very important. Click on the word **Setup**. The **Setup** screen should drop down. Now select **Design**. What should appear are five folders with only their tabs showing - the first one, **technology**, viewed entirely. The remaining tabs should be labeled **grid**, **selection**, **drawing**, and **Xref files** (see diagrams). The first folder, **technology**, serves to establish the *display units* and the *technology units* that are to be used in the layout, as well as specify the *internal unit* (in microns). (Internal units are the smallest possible units available in the L-Edit program). The default setting is *1 internal unit = 1/1000 microns*.

To aid the viewing, drawing, and editing of objects, L-Edit provides three independent grids - the *grid display*, the *mouse grid*, and the *manufacturing grid* – each of which divides the layout area into equal squares whose corners act as gridpoints. The settings for these grids can be found in the **grid** folder that appears in the middle diagram above. The first group of settings deals with the grid display. The *grid display* setting regulates the absolute spacing, in microns, between the major and minor gridpoints in the displayed grid. The default settings are: Major display grid 10 microns, Suppress major grid if less than 20 pixels, Display minor grid 1 micron, and Suppress minor grid if less than 8 pixels. Another setting that can be regulated, if desired, is the *suppress grid if less than*. If you enter a number larger than 87 for the major grid, or larger than 8 for the minor grid, then the corresponding grid is hidden.

The second group of settings controls the mouse grid. *Cursor type* is a setting that allows the user to decide between two types of pointers - a snapping pointer, where the only possible positions of the pointer are located at the mouse snap gridpoints, or a smooth pointer, where the pointer's position is unconstrained. Despite the choice, the default prefers that the user select a snapping pointer for convenience in drawing and editing. The second setting, *mouse snap grid*, simply sets the absolute spacing of the mouse snap grid. The default value is 1 micron.

The third folder, **selection**, has only one important setting. *Selection range* is basically the furthest distance (in microns) that one can move outside of an object with the pointer still be able to select it.

*** While settings can be changed as necessary, it is suggested that they remain as they appear in the previous diagrams for reasons benefiting the L-Edit beginner. As one becomes more experienced with creating layouts, changes should then be considered (when appropriate).

2.5. Program Options:

Although it is highly recommended that the L-Edit beginner stick with the default settings, changes can be made for general applications. To do so, select **Setup > Application** from the main menu. Once accessed, one may change editing options, adjust toolbars, and establish keyboard shortcuts.

2.6. Drawing in the Layout:

Drawing in L-Edit is not as complicated as it may seem. The best suggestion that can be made to a beginning L-Edit user, however, is to tinker and play with all the features that the drawing toolbar has to offer. It may take a little more time than reading a manual, but it will definitely pay off.

Boxes

Not only are boxes commonly used in circuit design, but they are also very easy to draw. Start by clicking the icon with the white rectangular box on it. Once the icon is selected, move the pointer to any area on the grid display (using the locator coordinate system as a guide) and click the desired point, making sure to hold down the mouse button. This is one corner of the box (called the anchor point). Now move the pointer to the intended opposite corner of the box and release the mouse button.

Circles

Circles, although used less often, are also very easy to make. Just as before, select an icon - this time it should be a circle. Start with an anchor point, which will act as the center of the circle. Select the desired location of the anchor point, click and hold the mouse button, move outward to any point, and release the mouse button when the selection is complete. The distance between the anchor point and the "outward point" is the radius of the circle.

Triangles

To make a triangle, first click on the icon represented by a triangle. Once the icon is selected, move the pointer to the grid display. Click the mouse button at the desired anchor point. This will act as one of the triangle's vertices. Move the pointer to a second point and click on that spot. This is the second vertex. Finally, move to a third spot and click the right mouse button. The triangle should now be complete. If one desires greater-sided angled polygons, the first two steps should be repeated for more vertices.

Wires

A wire consists of one or more rectangular segments joined at common ends. All segments in the wire have the same width, but each segment can have a different length. To draw a wire, first click on one of the wire icons (there are three to be exact). The first in the series allows only horizontal and vertical lines. The second includes 45° lines. The third is capable of drawing wires of all angles. Once a wire icon is chosen, select an area on the grid display where the wire is to begin. Click on this spot with the mouse button. To extend the wire, move to a second area and click on the mouse button again. This action can be continued for wires of indefinite length. Once the desired wire is sketched, click on the right mouse button to complete the wire design. (See **Setup > Layers > General** for default wire settings).

Note: Just because a wire appears to touch another object on the screen does not necessarily mean that it will form a connection during chip fabrication.

Polygons, Arcs, and Tori

These odd shapes are seldom used in the L-Edit program. If one desires to implement them in a design, refer to the L-Edit User Manual. Simply practicing with these icons will help tremendously.

2.7. Drawing Options:

Sometimes the L-Edit user may not be satisfied with the layers available in the layer palette. To change a layer (color, pattern, etc.), double-click on the desired layer. This should bring up the *Setup Layers* screen. (This screen can also be accessed through the main menu – **Setup > Layers**). Once this is done, the user can change the various properties associated with individual layers. Under the *General* tab, one may adjust default wire settings and tinker with electrical properties. To change layer colors or patterns, however, one must click on the *Rendering* tab. Here, the user may change a layer's color, mode (set or clear), and stipple (pattern). One may add or delete layers from all tabs.

The following options are useful in drawing and viewing various objects within the layout:

Flip/Rotate

Once objects are drawn, they can be flipped or rotated accordingly to fit the user's needs. To rotate an object 90°, simply select **Draw > Rotate** from the main menu, press *R* on the keyboard, or click on the icon that contains a shaded triangle standing up, an unshaded triangle laying down, and an arrow pointing from the unshaded triangle to the shaded triangle.

To flip an object (like one would flip a pancake), select **Draw > Flip > Horizontal** or **Vertical** from the main menu, press *H* for a horizontal flip or *V* for a vertical flip, or click on the *flip* icons – represented by shaded and unshaded triangles.

Hiding/Showing Layers

When dealing with multiple layers in a mask design, it is often necessary to view only certain layers at a time. To hide a particular layer, first select the layer from the layer palette. Double click the layer icon with the right mouse button. A screen should pop up and read *Show...* and then a layer name. Click on this to hide the specific layer. Click on it again to show the specific layer. The procedure can be repeated to *Show All* or *Hide All* layers. (When *Show All* is clicked, all layers are shown, regardless of the layer the process is started with. When *Hide All* is clicked, all layers are hidden except the layer the process is started with.) The same series of steps can be used to increase icon size, decrease icon size, turn on/off toolbars, etc.... (The hide/show commands can also be accessed through the main menu - **View > Layers > ...**).

Moving Objects

To move an object, first click on the object to be moved. Once the object is selected, hold down the *Alt* key and click-and-hold the mouse button. The object is now free to be moved. Once finished, simply release the mouse button. To move a large number of objects, simply select more objects and repeat the procedure.

Another way to move objects in the L-Edit program is through **Edit > Edit Object(s)**. This provides an exact way of placing objects in the layout using X-Y coordinate system (in microns).

Select All

Many times the L-Edit user may find it necessary to select all of the objects in the layout. To do so, select **Edit > Select All** from the main menu or press *Ctrl + A* on the keyboard.

Selecting Objects

To select a single object, click the object with the mouse button. To select more than one object, click on the mouse-pointer icon in the drawing toolbar and draw a box around the desired objects. Whatever objects are captured entirely by the box will be selected.

Undo/Redo

Objects can be undone and redone through the use of two icons in the standard toolbar. The undo icon is represented by an arrow emerging out of a page and bending toward the left. The redo icon is represented by an arrow emerging out of a page and bending toward the right. (Undo is the equivalent of pressing *Ctrl + Z* on the keyboard. Redo is the equivalent of pressing *Ctrl + Y* on the keyboard.)

2.8 Viewing Options:

The following options are very helpful in locating, viewing, and observing various objects within the layout:

Home

One helpful options that is very similar to the zoom option is the **Home** key. To view the entire layout, press the **Home** key on the keyboard. The program automatically sets the zoom to include all of the objects in the design.

Pan

The pan command allows one to move the viewing area to a desired location. Panning, which can only be done horizontally and vertically, requires the use of the arrow keys.

Zoom

Zooming in (for increased magnification) requires pressing the "+" key on the keyboard. Zooming out can be done by pressing the "-" key. These options are used very often.

2.9. Saving Files:

To save a modified file in the L-Edit program, simply click on **File** in the menu bar and scroll down to **Save**. Select this option and save the file as desired. It is recommended, however, that any personal file be stored in C:\Documents and Settings\YourFolder.

Note: When creating and saving individual cells, do not use parentheses or slashes/dashes of any kind. When possible, do not even use spaces. Letters (capital preferred) and numbers are allowed.

2.10. Creating Larger Photomasks:

As stated before, a *technology* is the equivalent of one layer in a mask design. L-Edit supports an unlimited number of technology layers. These are displayed in the layer palette as an arrangement of square icons that represents the available layers.... What does this all mean?

Well, first of all, L-Edit opens with one cell (or drawing window). This cell can be used to create very simple photomasks; however, more complicated photomasks require more attention. One simple way to go about making larger photomasks is to begin by drawing very articulate and detailed sections of the intended mask design in individual cells and then instancing them into a final cell. By this way, what would take days will take only a few hours.

Note: Each cell in a project should be contained within the same file. In the drawing below, the file Pattern Components contains the project cell Test Pattern which, in turn, is made up of all the other cells in the file.

Many photomasks require that more than one layer appear on the final design. This may be done by creating individual mask components of a particular layer and then instancing them as desired, paying particular attention to placement within the layout. Often it is more convenient to use one cell to include a several-layer structure, which is less prone to placement errors. In the diagram on the next page, each set of numbers, lines, and boxes was initially drawn in an individual cell and then transferred into the project cell called *Test Pattern*. Accurate positioning can be accomplished with help from the locator coordinate system. (Only two layers were used).

The **Select Cell to Edit** box in the picture above shows how cells are used in a mask design. The whole mask is stored under one file. In this case, the name of the file is *Pattern Components*. The cells, on the other hand, are listed below the file name. (The number of cells can become very large for an extensive mask project).

2.11. Using Cells:

Every file opens up with a single cell. To open existing cells in a file, use the **Cell > Open** command. When size becomes an issue, more cells can be made. New cells are created with the **Cell > New** command.

***** In naming cells, do not use parentheses or slashes/dashes of any kind. When possible, do not even use spaces. Letters (capital preferred) and numbers are allowed.**

Each new cell must be given a unique name. If, in any case, a cell needs to be renamed, this can be done with the **Cell > Rename** command.

2.12. Instancing Cells:

To *instance* a cell is to copy it into another cell. As stated earlier, each set of detailed components in the project mentioned previously was instanced into the main cell called *Test Pattern*. First, the user must access the cell into which other cells are to be instanced. Then one can instance a cell through **Cell > Instance** in the main menu or by pressing the *Insert* key on the keyboard. Select the cell to instance. (Only one cell can be instanced at any time).

Note: A cell's features can not be changed in its "instanced" form. To make the necessary changes, one must return to the original cell (pre-instanced) and configure it accordingly. L-Edit automatically modifies any cells in the project that carry the same name as the original cell.

3. Mask File

When all is completed in a mask design, the file must be saved or stored in a safe location. In that most mask fabricators accept mask file in the format of GDSII. How to save file in GDSII will be detailed next.

Before doing anything else, make sure that the layers in the mask design being created have GDSII numbers assigned to them. Companies recognize layers in a mask design through the use of these numbers. Also, it is impossible to export/import mask data without assigning numbers to the desired layers. To assign a number (L-Edit allows numbers ranging form 1-64), simply select **Setup > Layers** from the main menu and make sure to click on the *General* tab on the pop-up screen. Toward the right side of the screen, there is an area that reads *Import/Export...GDSII number:, CIF name:.* For each layer that is to be developed in the final mask produced by the company, a GDSII number must be specified.

To export the mask design data from the computer so that the photomask company recognizes what it is that the customer desires, simply click on **File > Export Mask Data**. Designate a safe area to store the exported data in the *To file:* section and specify the *Export file type* as GDSII. Before proceeding with sending off the data file via e-mail (as an attachment), make sure that the exported data was truly exported. In other words, import the data file back into the computer to check if everything appear as it should. In the L-Edit main menu, select **File > Import Mask Data**. Browse and find the file in which the initial exported data was stored. This should be done in the *From file:* section, as shown in the diagram above. Next, specify the *Import file type*. If the initial file was exported as a GDSII file, it should be imported the same way. Last, but not least, check to make sure the *Use setup file:* contains the same basic layout as the exported/imported file.

If all goes well, no warnings should appear on the screen during both the export and the import procedures. If warnings do appear and the error is not evident, contact the L-Edit Customer Support team.

4. Index

4.1. License Information:

Tanner Research, Inc. grants a license to use the L-Edit software but does not grant the right to reproduce, prepare derivative works nor distribute the software. The L-Edit program is owned and maintained by:

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