

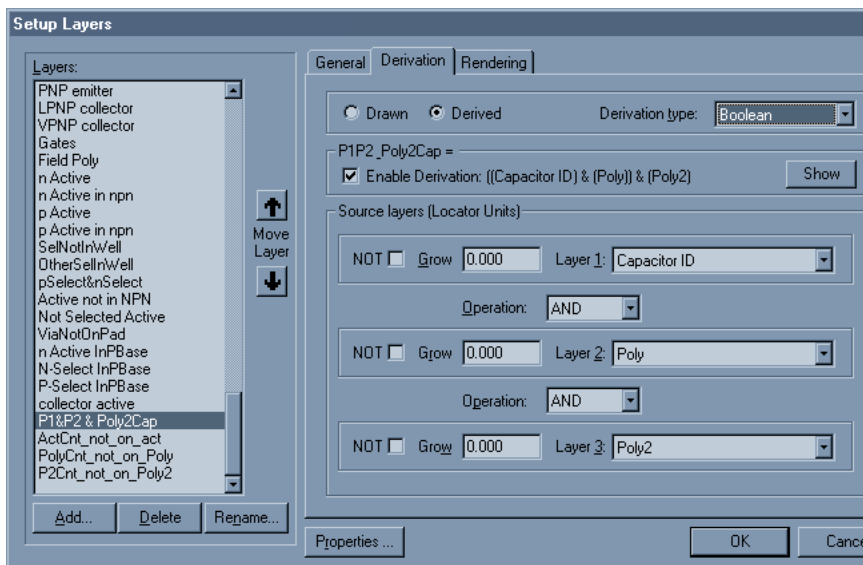
# 11      Generating Layers

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- Introduction to Generated Layers 1-436
- Defining Boolean Layer Derivations 1-441
- Defining Select Layer Derivations 1-450
- Defining Area Layer Derivations 1-463
- Defining Density Layer Derivations 1-466
- Creating Generated Layers 1-469
- Working with Generated Layers 1-473
- Working with 45° Objects 1-476

# Introduction to Generated Layers

L-Edit allows you to develop generated layers based on operations and selections made to existing layers. You define generated layers with the **Setup Layers** dialog.



To open **Setup Layers**, choose **Setup > Layers**, or double-click anywhere on the layers palette.

Derived layers can be created using Boolean, select, and area operations.

Boolean operations allow you to create polygons according to their logical relationship to each other using the AND, OR and NOT operators. Select operations let you define polygons based on area relationships between layers. Area operations let you select polygons by their area.

You can also define a Boolean NOT case for each of the derivation types, which provides the complimentary output of a given operation.

Note that polygons on both layer 1 and layer 2 are automatically merged during layer generation.

## Derivation Steps

To create a generated layer, first add a name for the generated layer to the layer list, and then define its characteristics. The target layer—the layer on which the operation results will be drawn—is always the layer that is highlighted in the **Layers** list.

Any previously listed layer, including previously generated layers, may be used in the definition of a generated layer. The new layer name must be inserted in the layer list *after* the names of the layers which are involved in its creation. For

example, if you define a Gate layer as Poly AND Active, then Gate must come after Poly and Active in the layer list.

Then use **Tools > Generate Layers** to execute generation. Objects on generated layers are automatically created (generated) during the generate layers operation (see [Creating Generated Layers on page 1-469.](#))

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**Note:**

The generate layers operation only operates on boxes and 45°/90° polygons and wires. It does not operate on circles or all-angle objects.

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## Enable Derivation

All types of derived layers provide the option to toggle layer generation on or off using the **Enable Derivation** checkbox. When this box checked, a derived layer is not included in any of the layer generation procedure.

If you have derived layers with the **Enable Derivation** option turned off, geometry will not be removed from those layers during the **Tools > Clear Generated Layers** operation.

**Tools > Generate Layers** will only generate objects on layers that have **Enable Derivation** turned on, and with the **Delete all derived layers prior to generation** box checked, only objects from layers with **Enable Derivation** turned on will be deleted.

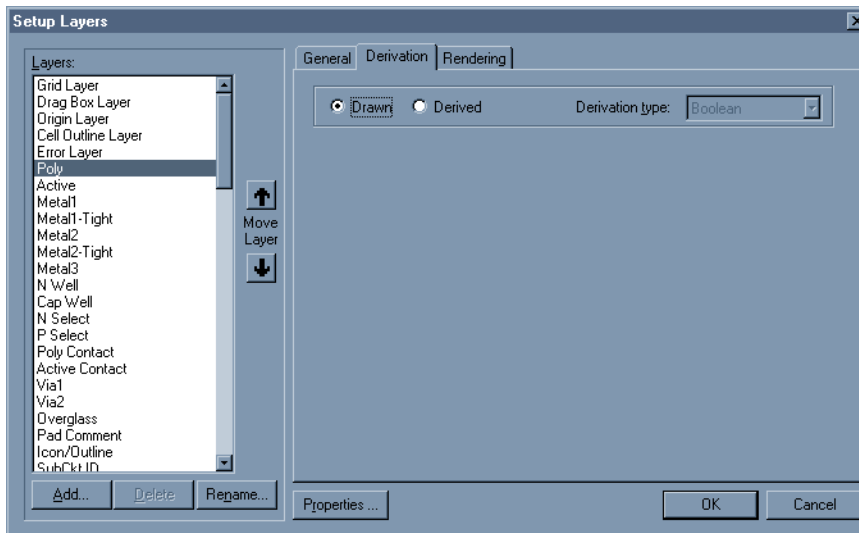
Similarly, **View > Layers > Show Generated Layers** and **Hide Generated Layers** will only toggle visibility of those layers that have derivation enabled.

**DRC**, **Extract** and **Generate Cross Section** will only delete and regenerate a layer, or remove objects from it, if derivation is enabled. However, all three operations are applied to all visible layers, regardless of how objects on the layer were created.

In no case does disabling derivation convert a derived layer into a drawn layer.

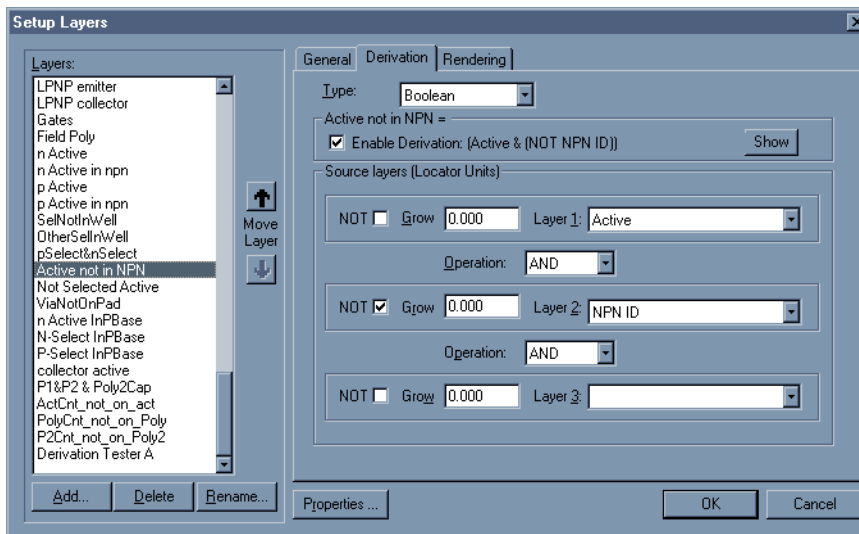
## Drawn Layers

Layers that are not derived from others are called **Drawn** layers..



## Defining Boolean Layer Derivations

To define generated layers using Boolean operators, click on the **Derivation** tab in **Setup Layers** and select Boolean from the **Type** drop-down menu.



You use this dialog to pick the name of the generated layer, specify up to three source layers, and compose the Boolean operations performed to create the new layer. Note that operations are always evaluated from top to bottom.

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**Note:** The generated layer must be positioned in the **Layers** list below each of its source layers.

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The options used in designating the source layers are as follows:

<b>Type</b>	Choose the <b>Boolean</b> derivation type from the drop-down list.
<b>Enable Derivation</b>	When this box is checked and source layer information is entered, the named layer can be generated. Use this option to activate or deactivate the generation of a particular derived layer without changing other setup information.
<b>Show</b>	Opens the dialog <b>Full Derivation</b> , which shows the derivation for the selected layer and all of its source layers in terms of drawn (mask) layers.



**Source layers (Locator Units)****Layer 1... Layer 2... Layer 3**

Existing layers from which the new layer will be created (derived). Select each source layer from the drop-down list. Only layers listed above the target layer are available.

Choose one of the following operations to apply to a source layer:

- **NOT**—when this box is checked, the complement of the source layer is used.
- **GROW**—enter a positive or negative integer for the amount, in locator units, by which objects on the source layer are grown or shrunk on the derived layer. Objects grow or shrink uniformly by the given quantity.

**Operation**

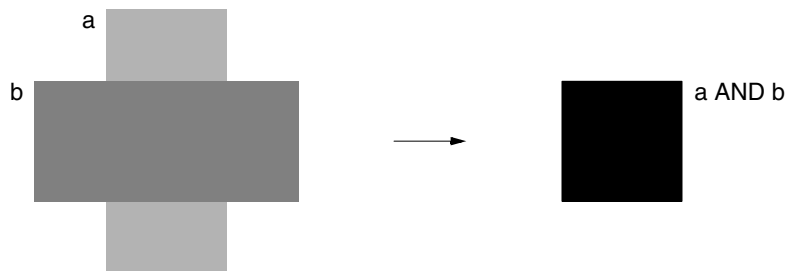
Select a Boolean **AND** or **OR** from the drop-down lists between layers to specify pairwise operations. For example, if **Layer 1** is *Poly* and **Layer 2** is *Active*, choosing **AND** between them results in *Poly & Active* for the derived layer.

## Boolean Operations in Generated Layers

Three elementary Boolean operations can be applied to previously defined layers: **AND** (page 1-444), **OR** (page 1-445), **NOT** (page 1-445). L-Edit also performs the **Grow** (page 1-446) operation, used to oversize or undersize (shrink) objects. These operations can be used individually or combined to produce more complex formulas.

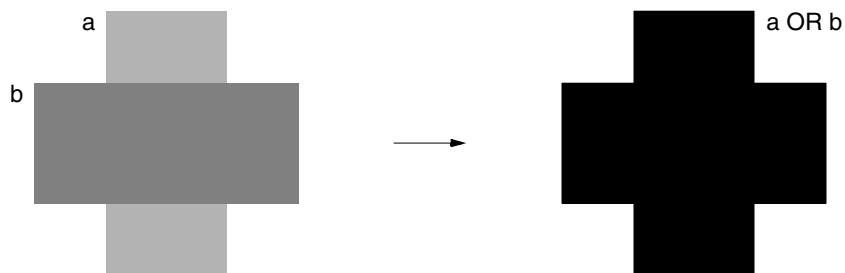
### *AND*

The **AND** operation (abbreviated **&**) creates objects on a generated layer from the intersection of objects on two other layers.



## *OR*

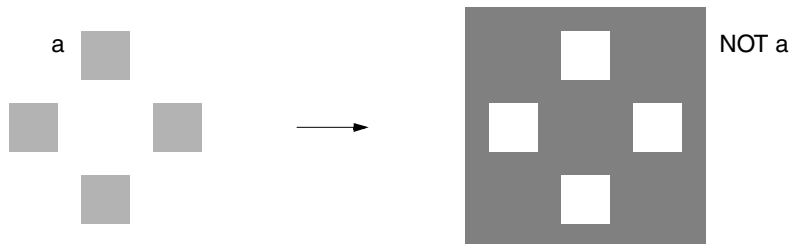
The **OR** operation (abbreviated **I**) creates objects on a generated layer from the union of objects on two other layers.



## *NOT*

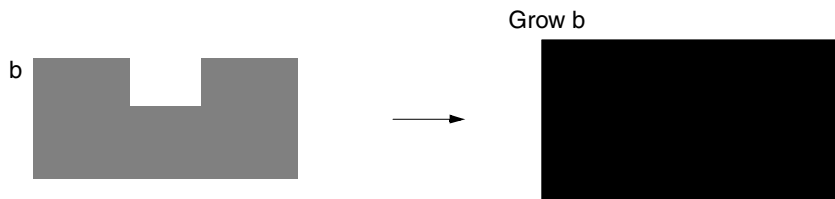
The **NOT** operation creates objects on a generated layer based on the absence, or inverse, of objects on another layer. Mathematically, the generated layer should extend throughout the layout area wherever the original layer does not exist.

L-Edit imposes an artificial outer boundary as large as the area including all existing objects, plus an additional area to guarantee the correctness of all **GROW** operations.



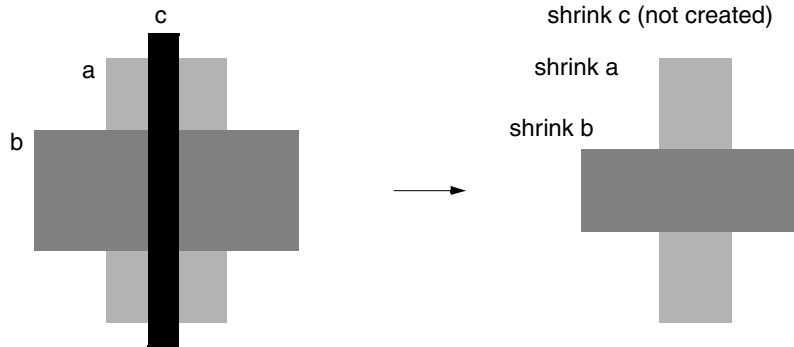
## Grow

The **Grow** operation creates objects on a generated layer by increasing the size of each object on the original layer. Specifically, a **Grow** operation displaces each edge by the specified number of locator units.



A negative **Grow** parameter yields a shrink operation, creating objects on a generated layer by displacing the edge of each object on the original layer inward by the specified number of locator units.

If any dimension of an object is less than or equal to twice the shrink amount, a new object will not be created on the generated layer.



## Order of Operations

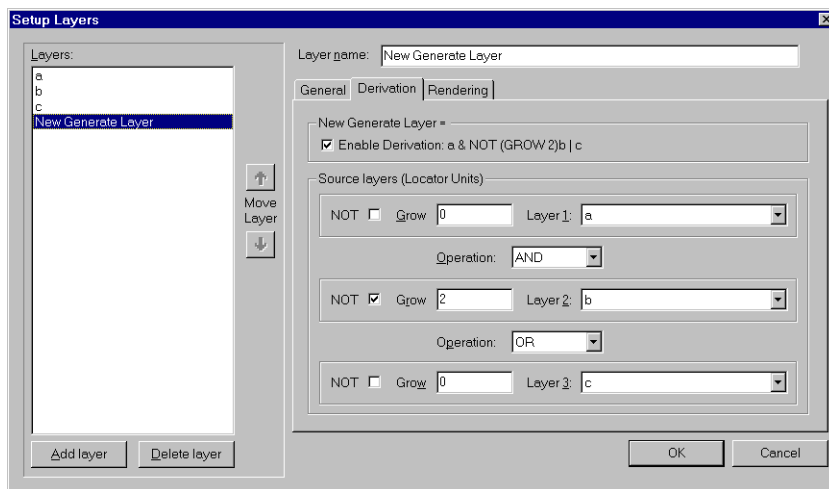
Boolean operations are performed on the source layers in the following order:

- [1] **Grow** (individually)
- [2] **NOT** (individually)

[3] **AND/OR** (first to last)

For example, if the source layers consisted of layers *a*, *b*, and *c*, and you specified the following operations: **NOT** and **Grow 2** on *b*; **AND** between *a* and *b*; **OR** between *b* and *c*—the actual result would be (*a* **AND** (**NOT**(**Grow 2** *b*))) **OR** *c*.

**AND** has higher precedence than **OR**. For example, *a* **AND** *b* **OR** *c* is read as (*a* **AND** *b*) **OR** *c*, and *c* **OR** *a* **AND** *b* is read as *c* **OR** (*a* **AND** *b*).

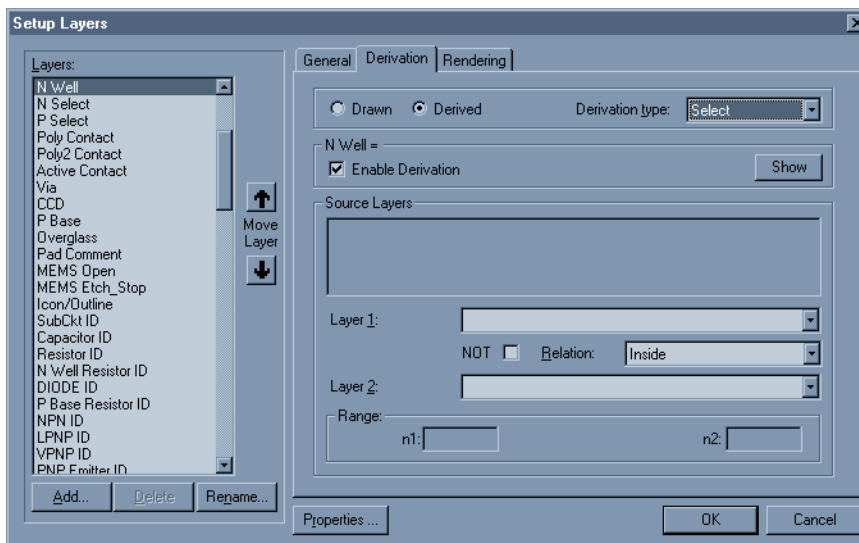


In such a case, the operations would be performed as follows:

- [1]     **Grow** 2 on  $b$
  - [2]     **NOT** on the result of step 1
  - [3]     **AND** between  $a$  and the result of step 2
- OR** between the result of step 3 and  $c$ .

## Defining Select Layer Derivations

Select operations allow you to define a relationship that selects a group of polygons from a layer and creates a new layer with the results. These operations allow you to create rules that cannot be made with logical operations, such as spacing checks and sizing checks.





The options used in designating the select layer are:

<b>Type</b>	Choose the <b>Select</b> derivation type from the drop-down list.
<b>Enable Derivation</b>	When this box is checked and source layer information is entered, the named layer can be generated. Use this option to activate or deactivate the generation of a particular derived layer without changing other setup information.
<b>Show</b>	Opens the dialog <b>Full Derivation</b> , which shows the derivation for the selected layer and all of its source layers in terms of drawn (mask) layers.
<b>Source Layers Layer 1, Layer 2</b>	Existing layers from which the new layer will be created (derived). Select each source layer from the drop-down list. Only layers listed prior to the target layer are available.
<b>NOT</b>	When this box is checked, the NOT of the relation is applied.

**Relation**

Choose one of the following select relationships from the drop-down list:

- **Inside** (page 1-453)
- **Outside** (page 1-455)
- **Hole** (page 1-457)
- **Cut** (page 1-458)
- **Touch** (page 1-460)
- **Enclose** (page 1-462)
- **Overlap** (page 1-462)
- **Vertex** (page 1-462)

**n1, n2**

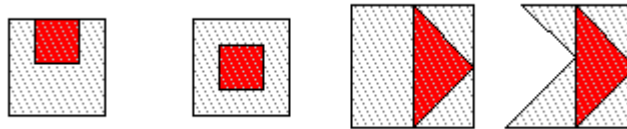
Enter a minimum (**n1**) and maximum (**n2**) value (exclusive) to define the vertex count range.

## Select Operations in Generated Layers

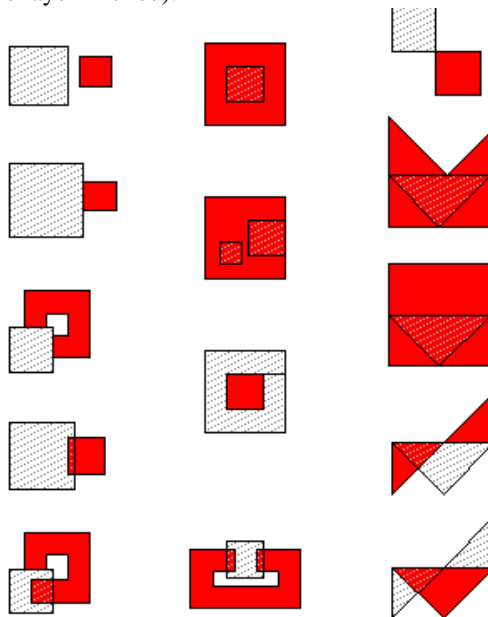
The select relationships are described and illustrated below.

## *Inside*

The **inside** operation selects layer 1 polygons that are completely contained in layer 2 polygons, as shown below (where layer 1 is red).

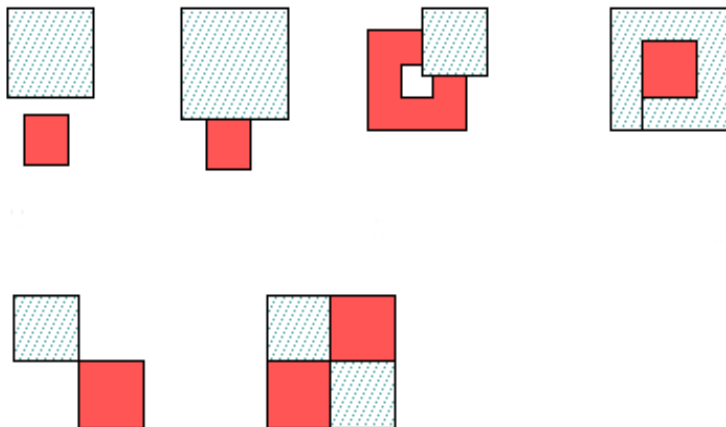


The **not inside** operation selects layer 1 polygons that are NOT completely contained in layer 2 polygons (equivalent to **outside** or **cut**), as shown below (where layer 1 is red).

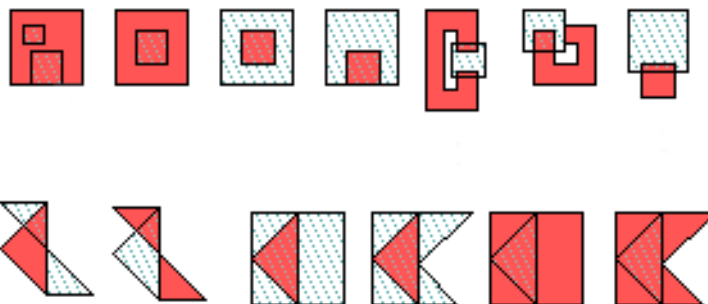


## Outside

The **outside** operation selects layer 1 polygons that are completely outside of layer 2 polygons, as shown below (where layer 1 is red).

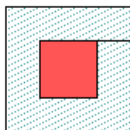


The **not outside** operation selects layer 1 polygons that are not completely outside layer 2 polygons (equivalent to **inside** or **cut**), as shown below (where layer 1 is red).



## *Hole*

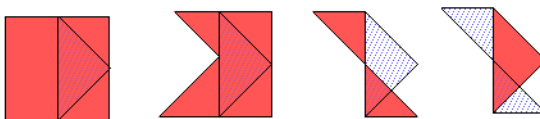
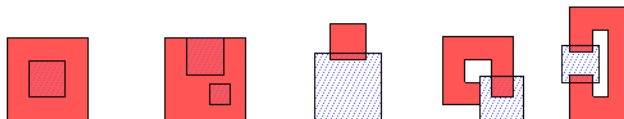
The **hole** operation selects layer 1 polygons that have their entire outside surface exactly touching the outside surface of a layer 2 polygon, as shown below (where layer 1 is red).



The **not hole** operation selects any layer 1 polygons that do not exactly fill a hole in a layer 2 polygon.

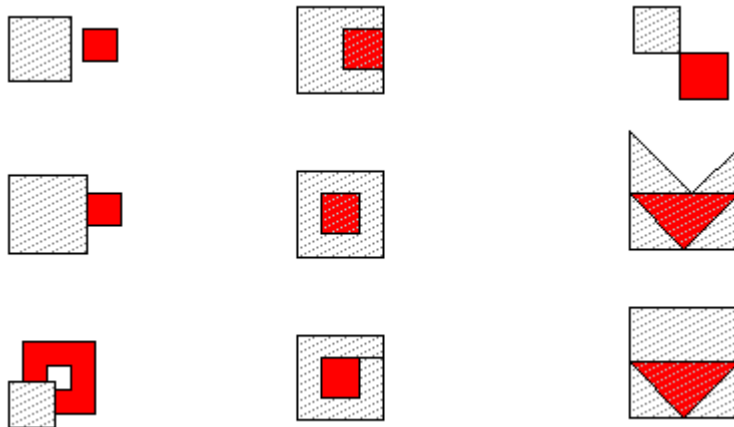
## Cut

The **cut** operation selects layer 1 polygons that intersect but do not just touch layer 2 polygons, so that they have areas that are both inside and outside of layer 2 polygons, as shown below (where layer 1 is red).



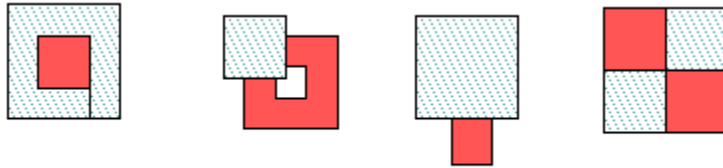


The **not cut** operation selects layer 1 polygons that are either completely inside of or completely outside of, and do not touch, layer 2 polygons, as shown below (where layer 1 is red).

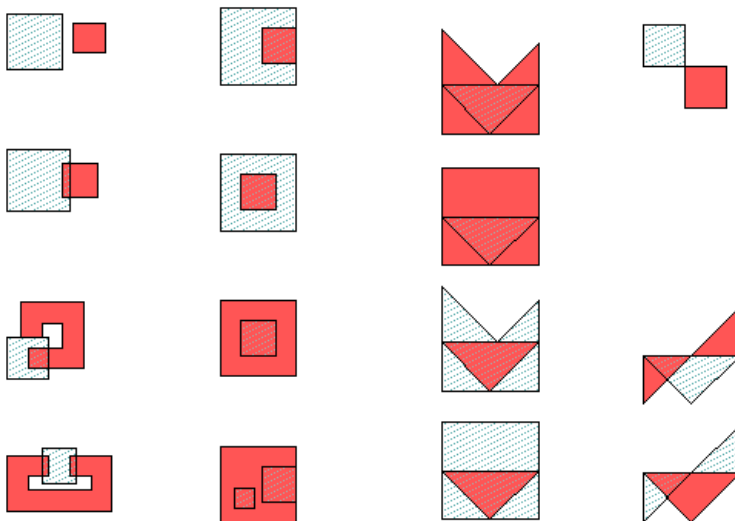


## *Touch*

The **touch** operation selects layer 1 polygons that touch layer 2 polygons from the outside and do not also cut, as shown below (where layer 1 is red).



The **not touch** operation selects layer 1 polygons that do not touch layer 2 polygons, as shown below (where layer 1 is red).



## *Enclose*

The **enclose** operation selects layer 1 polygons that completely enclose layer 2 polygons. This includes layer 1 polygons that are inside and touching layer 2 polygons. The enclose operation is shown below, where layer 1 is red.

The **not enclose** operation selects layer 1 polygons that do not completely enclose layer 2 polygons.

## *Overlap*

The **overlap** operation selects layer 1 polygons that touch, cut, enclose or are inside of layer 2 polygons.

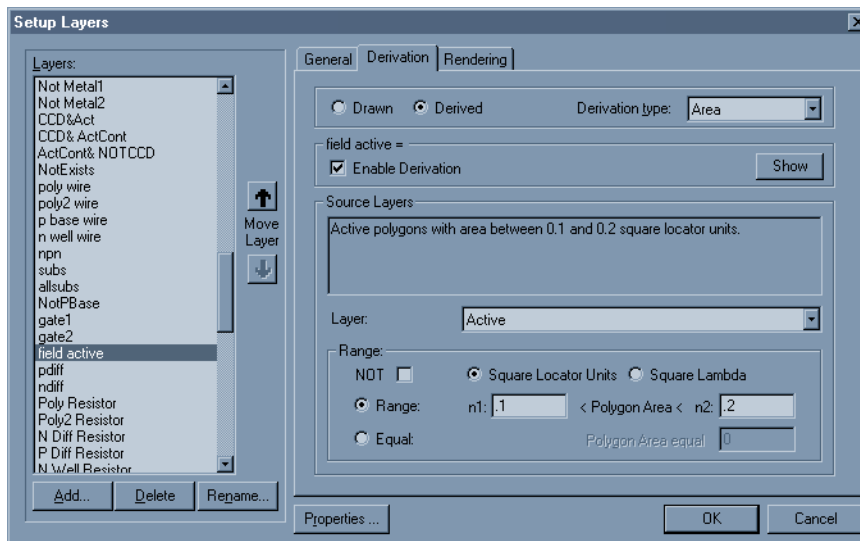
The **not overlap** operation selects layer 1 polygons that are entirely outside of layer 2 polygons.

## *Vertex*

The **vertex** operation selects layer 1 polygons with more than or equal to a specified minimum number and fewer than or equal to a specified maximum number of vertices. The **not vertex** operation selects layer 1 polygons with fewer than the minimum number or more than the maximum number of vertices.

## Defining Area Layer Derivations

The **Area** option in the Derivation tab checks polygons on the selected layer to determine if their areas are equal to a specified area or are within a specified area range.



The parameters used in designating the minimum area check are:

<b>Type</b>	Choose the <b>area</b> derivation type from the drop-down list.
<b>Enable Derivation</b>	When this box is checked and source layer information is entered, the named layer can be generated. Use this option to activate or deactivate the generation of a particular derived layer without changing other setup information.
<b>Show</b>	Opens the dialog <b>Full Derivation</b> , which shows the derivation for the selected layer and all of its source layers in terms of drawn (mask) layers.
<b>Source Layers</b>	Existing layers from which the new layer will be created (derived). Select each source layer from the drop-down list. Only layers listed prior to the target layer are available.
<b>NOT</b>	When this box is checked, the NOT of the relation is used, so polygons with area outside the specified range are flagged.

**Square Locator Units**

or

**Square Lambda**

Select one of these radio buttons to set the units for area calculation. As with the rule distance in **Setup Design Rules**, (see [Specifying Design Rules on page 3-69](#)) areas do not get rescaled when **Square Locator Units** is selected, but do get rescaled when **Square Lambda** are used.

**Range**

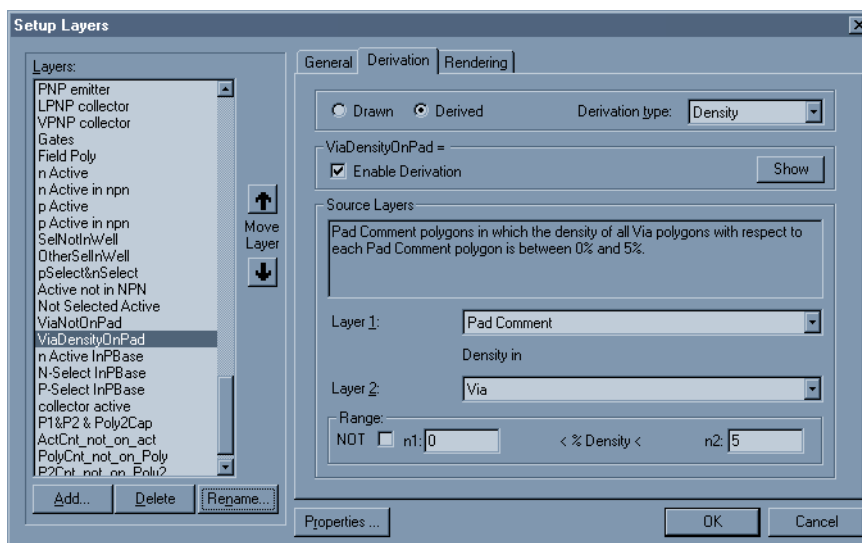
or

**Equal**

Click one of these radio buttons to pick either polygons with an area in the range specified in **n1** and **n2** (exclusive) or polygons equal in area to the value entered in **Equal**.

## Defining Density Layer Derivations

Certain design rules require testing of the percentage of area covered by a certain layer. The density operation selects polygons based on the percentage of area that one layer covers in an area defined by another layer. The selected objects can then be used in a density DRC rule.





The **density** operation selects layer 1 polygons in which the density of layer 2 polygons in each object on layer 1 is between a minimum and maximum percentage.

The **not density** operation selects layer 1 polygons in which the density of layer 2 polygons is less than a minimum percentage or greater than the maximum percentage. Valid range values are between 0 and 100 percent, where **n1** must be less than or equal to **n2**.

The options used in designating the density layer are:

#### **Derivation Type**

Choose **Density** from the drop-down list.

#### **Enable Derivation**

When this box is checked and source layer information is entered, the named layer can be generated. Use this option to activate or deactivate the generation of a particular derived layer without changing other setup information.

#### **Show**

Opens the dialog **Full Derivation**, which shows the derivation for the selected layer and all of its source layers in terms of drawn (mask) layers.

#### **NOT**

When this box is checked, the NOT of the relation is applied.

**Layer 1, Layer 2**

Existing layers from which the new layer will be derived. Select each source layer from the drop-down list. Only layers listed above the target layer are available.

**n1, n2**

Enter a minimum (**n1**) and maximum (**n2**) value (exclusive) to define the density range.

Layer 1 is defined as the reference layer, and layer 2 as the layer whose density you are checking. L-Edit calculates the area density of layer 2 that exists inside each polygon of layer 1, and outputs the layer 1 polygon if the density is within the specified range.

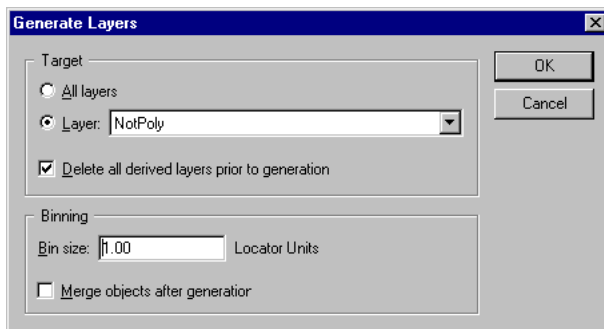
Specifically, for each polygon **P** in **layer 1**, L-Edit calculates:

$$\text{density} = (\text{area of (P AND layer 2)}) / (\text{area of P}) \times 100\%$$

then outputs **P** to the derived layer if the density is in the specified range (or not in the given range if **NOT** is turned on).

## Creating Generated Layers

After generated layers have been defined, they can be created in the active cell with **Tools > Generate Layers**. L-Edit displays the **Generate Layers** dialog.



Options include:

### Target

Layer to be generated. Options include:

- **All layers**
- **Layer**—a single layer, selected from the drop-down menu

If a generated layer is derived from source layers that are themselves generated, the source layers are recursively generated as well.

Ports on generated layers are always ignored.

### Delete all derived layers prior to generation

Clears objects on all pre-existing derived layers. When generating a single **Layer**, use this option to clear objects on other derived layers or layers for which derivation is disabled.

### Binning

L-Edit divides the layout into a grid of square bins and performs layer generation within each bin. Choosing the optimal bin size significantly increases performance because objects that are distant from one another are not involved together in layer-generation operations.

**Bin size**

Length of one side of a bin.

Note that the actual bin size used to generate layers is snapped up to a multiple of the mouse snapping grid (set in **Setup Design > Grid > Mouse snap** grid) to avoid generating off-grid polygons.

**Merge objects after generation**

Causes objects on the same generated layer to be merged upon completion of the process. This option can significantly increase processing time for more complex layouts.

**Warning:**


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If a source layer for generation is locked or hidden, or if the **Enable Derivation** option (in the **Setup Layers** dialog) for the target layer is off, L-Edit ignores objects on that layer.

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When you execute the **Generate Layers** command, L-Edit automatically deletes existing objects on generated layers before regenerating those layers. If you generate only a single layer, however, L-Edit does not delete objects on other derived layers.

To delete such objects, check the option **Delete all derived layers prior to generation**. Similarly, if generation is disabled for a particular layer, L-Edit does

not automatically delete objects on that layer before generating other layers. You can also delete such objects using **Delete all derived layers prior to generation**.



## Working with Generated Layers

Objects on generated layers behave like other L-Edit objects. They can be edited, shown, locked, and hidden in the same way.

### Showing, Hiding, and Locking Generated Layers

Use the menu commands **View > Layers > Show Generated** and **View > Layers > Hide Generated** to show and hide generated layers. (See [Showing and Hiding Layers on page 1-230](#).) If the current layer is a generated layer, it will remain visible when generated layers are hidden.

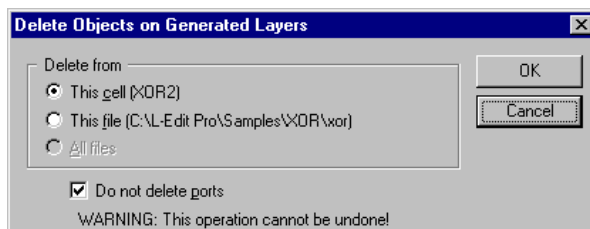
You can also show or hide generated layers using the context-sensitive menu on the layer palette, just as you would any other layer. With the pointer over any *non-generated layer* icon, click the right mouse button and choose **Hide Generated**. All generated layers will be hidden and their icons shaded on the layer palette.

To hide all generated layers *except* the selected layer, position the pointer over the desired *generated layer* icon and choose **Hide Generated** in the context-sensitive menu. Choose **Show Generated** to display all generated layers in all cells for the active file.

Finally, you can lock generated layers, just as you would any other layer. With the pointer over any *non-generated layer* icon, click the right mouse button and choose **Lock *generated\_layer\_name***.

## Removing Generated Layers

**Tools > Clear Generated Layers** removes all generated layers from the active cell, the active file, or from all open files. All objects on those layers are deleted, regardless of how they were created. This command cannot be undone.



Options include:

<b>This Cell (<i>cell name</i>)</b>	Removes generated layers in the active cell.
<b>This File (<i>file name</i>)</b>	Removes generated layers in the active file.
<b>All Files</b>	Removes generated layers in all open files.



**Do not delete ports**

Prevents L-Edit from removing ports on the generated layers in the specified file or cell. Use this option when your design uses a generated layer as its extract recognition layer and you want to retain the ports on this layer.

## Automatic Layer Generation with DRC and Extract

L-Edit automatically generates objects on derived layers before DRC and Extract runs and clears those objects afterwards. It only deletes objects generated during that DRC or Extract run, however—previously generated objects remain.

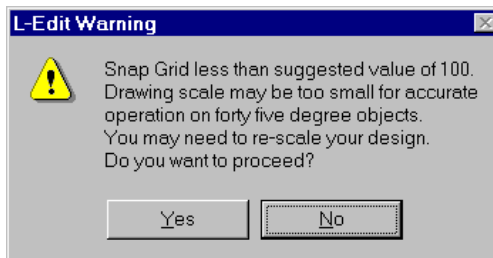
# Working with 45° Objects

## Layer Generation

Generation of layers containing 45° objects, either directly using the **Generate Layers** dialog (see [Creating Generated Layers on page 1-469](#)) or automatically via **Tools > DRC** or **Tools > Extract**, can produce off-grid vertices due to off-grid intersections of 45° polygons or conversion of 45° wires to polygons (see [Wires on page 1-478](#)). The coordinates of off-grid vertices are rounded to the nearest internal unit while still preserving angles of edges. If the dimensions of the source objects (measured in internal units) are small, then the resulting polygons may be distorted.

To prevent distortion of generated objects due to rounding of grid coordinates, you should maintain a *subgrid*. The subgrid is the smallest possible nonzero value, in internal units, of any edge length, wire width, distance between any two objects, or **Grow** distance. The best way to maintain a subgrid is to set the mouse snap grid parameter to prevent objects or spacings smaller than this value from being created (see [Grid Parameters on page 1-138](#)). A snap grid equivalent to at least 100 internal units is recommended for designs containing 45° objects.

When you generate layers or run DRC or Extract, L-Edit checks the snap grid parameter. If it is less than 100 internal units, L-Edit assumes that edges or spacings smaller than 100 internal units may exist on the layout, and the warning appears, suggesting that the layout may need to be rescaled.



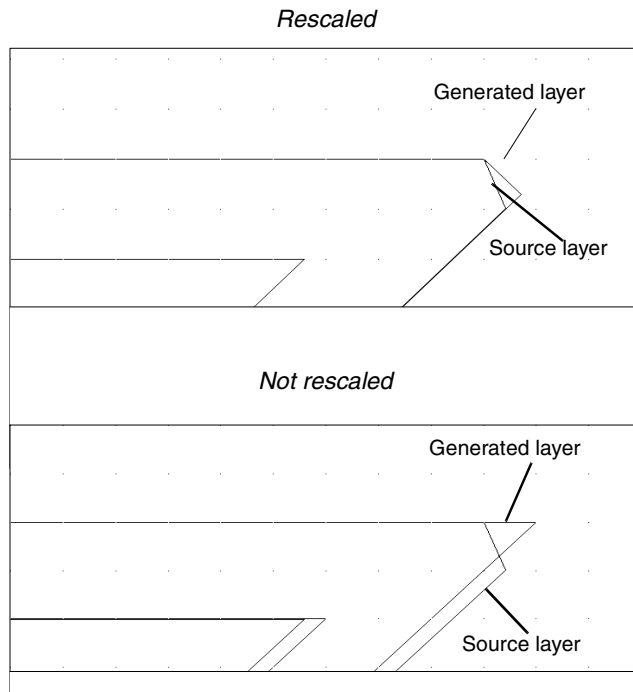
If you are certain that no edges, wire widths, spacing, or **Grow** values smaller than 100 internal units exist, then you may click **Yes** and proceed. Changing the snap parameter to an equivalent of 100 internal units prevents the warning from appearing (see [Grid Parameters on page 1-138](#)).

The equivalent number of internal units is based on the snap grid value (in locator units) and the number of internal units per locator units. It is up to you to make sure that no objects smaller than the subgrid are created; the warning depends only on the current value of the snap grid, not on the actual size of objects in the layout. You can rescale the design by increasing the number of internal units per grid point—that is, by increasing the number of internal units per technology unit.

## Wires

Wires involved in layer-generation operations on the source layers are converted to polygons on the generated layer. However, some join styles on 45° wires result in wire edges that meet at non-45° angles. To ensure that the resulting objects are true 45° polygons when the layer is generated, the problem joins are modified. Round joins are processed as layout joins and round ends are processed as butt ends to satisfy the 45° polygon criteria.

Examples of a converted 45° source wire to a generated layer polygon are shown in the following figure:



After rescaling, the finer grid resolution (more internal units per grid unit) allows the generated polygon to approximate the source wire more closely. Without

rescaling the design, the vertex of the generated polygon in the above example is forced to the nearest grid point that maintains a  $45^\circ$  angle.

