Supermax ECAD

Embedding Ohmega-Ply® Resistors

The ultimate design tool for thin film resistors.

Advanced capabilities for Ohmega-Ply® embedded resistor design.

- Automatic synthesis of resistors from component values
- Edit components online with dynamic resistance feed back.
- Any form geometry for pads and resistance areas let you create resistors of any shape
- Parametric resistor types: L-shape, serpentine, rectangle
- Any number of resistor layers
- Automatic generation of all production documents
- Firmly integrated with common schematic environments such as Cadence Concept HDL, Mentor Design Architect, Innoveda DxDesigner and OrCad Caputre
- Integrated with analysis tools and virtual prototyping environments
- Test netlist per IPC-D-356B
- Read and write popular CAD formats such as PADS, Mentor and Cadence
- Read and write many standard formats such as GDS-II, DXF and Gerber
- Valor ODB++ output
- Design kit, tutorials and sample designs available free of charge

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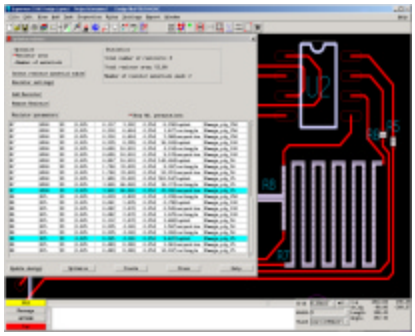
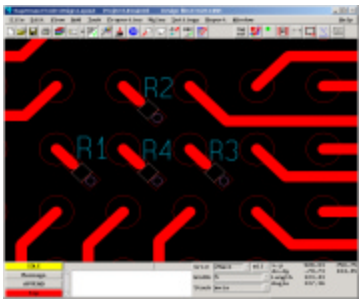
The Ohmega-Ply® thin film embedded resistor technology is at home in Supermax ECAD. The inherent understanding of embedded passives and automatic synthesis of parametric resistors makes Supermax ECAD the optimal design tool choice for Ohmega-Ply® resistors.

With Supermax ECAD, the design process is even faster than with conventionally discrete components as no library is required. Resistors are automatically synthesized from component values usually available as properties from the schematic.



The synthesis takes nominal value, trimable range, tolerance, power rating, aspect ratio and geometry into account. The generated resistors can be interactively edited with dynamic feed back of the resulting resistance.

A comprehensive Design Kit is available and together with sample designs and an instructive tutorial design guide, technology introduction is made fast, flexible, and correct.



With Supermax ECAD, design specifications are readily met with an extensive rules set and online DRC of electrical rules and manufacturing rules. Online verification of signal integrity rules, wire bonding rules, clearance rules, trace resistance, impedance and propagation delays.

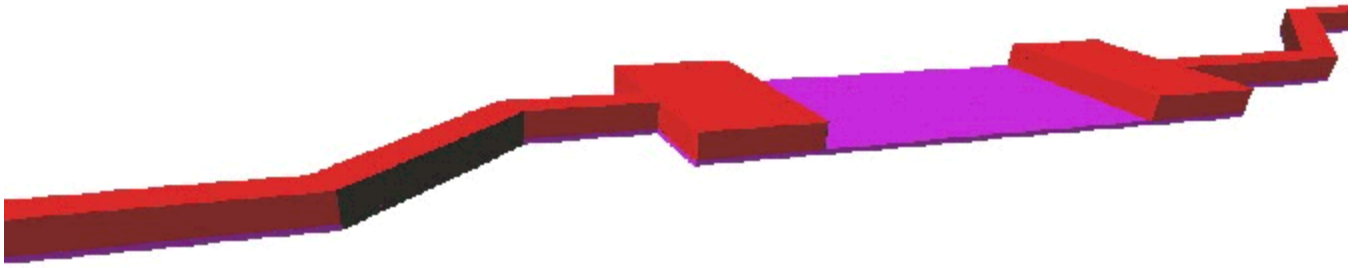
With our efficient CAM wizard, quickly generate manufacturing output for standard formats or utilize the API to access your design for custom output formats.

Embedding components is a promising technology offering a competitive edge for early adopters. Supermax ECAD helps you meet the challenge.

Supermax® ECAD – Flexibility at your fingertips.

Home → Guides

Ohmega-Ply® resistor design in Supermax ECAD



The Ohmega-Ply® resistor design in Supermax ECAD contains following chapters:

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1. Overview

Due to the nature of embedded passives technology, many special requirements are put on the CAD environment. Supermax ECAD meets the requirements and provides efficient design automation.

To make a design with many embedded resistors, it is not possible to manually create the resistors as fixed graphic images. Instead, the system must automatically generate (synthesize) the resistors from the component values allowing you to design any number of resistors in different values and

to different requirements in seconds rather than days or weeks.

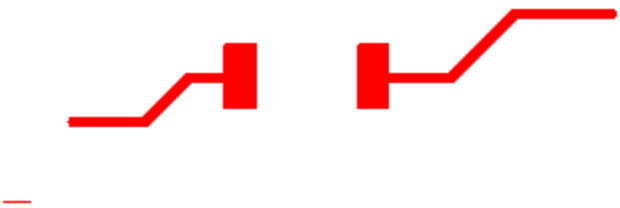
This document describes how to use Supermax ECAD in Ohmega-Ply® thin film embedded resistor design with optimal design automation.

As an introduction, let us as a start with the basic structure of an Ohmega-Ply®resistor and the production documents that are needed.

Ohmega-Ply® is a subtractive technology where the manufacturing starts with laminate with a thin film resistance material under the copper.

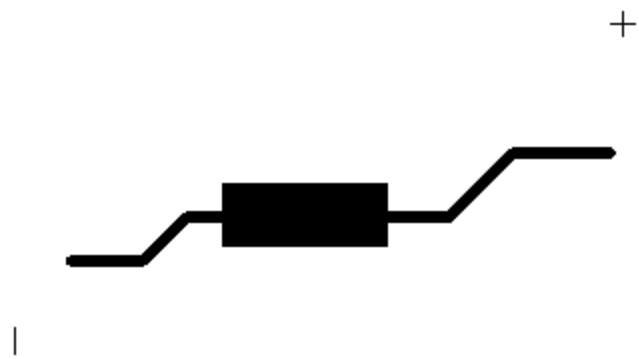
The first production film is a Gerber, extended Gerber or ODB++ document with the pad and trace layer merged with the resistor body layer.

This picture shows the pad /trace layer for a resistor.



This picture shows the resistor body layer.

The combined Gerber film result.

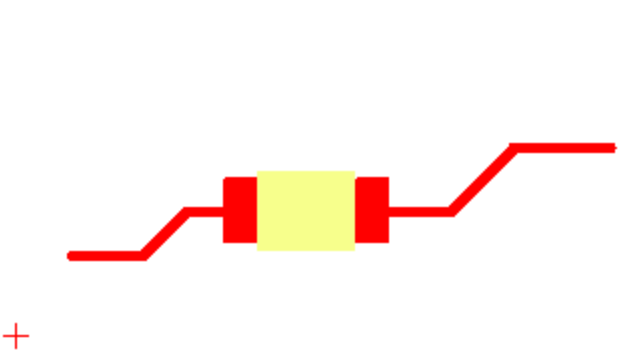


After this production step, the metal between the resistor pads is etched away leaving the resistive thin film material intact to form a resistor.

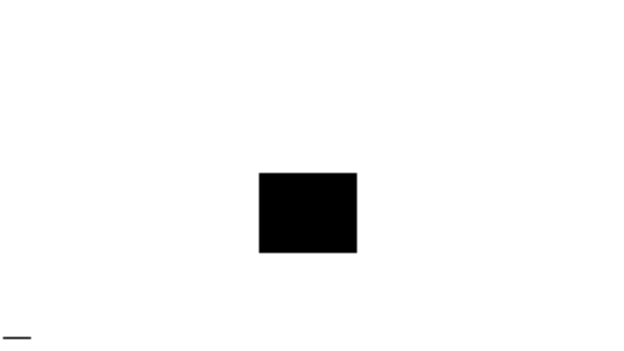
This step requires a film with a so called **resistor definition mask** having the exact length of the resistor body but added approximately 0.005inch in width.

This is to compensate for misregistration of the mask. If in this example, the mask is displaced in horizontal direction, the resistor body is simply moved a little to the left or right leaving the the resistance value untouched.

Should the mask be dislocated in vertical direction, the oversize of the mask will prevent copper from the resistor body of being exposed. Otherwise, the etching will leave a narrow sliver of copper along the resistor edge effectively causing a short circuit!



This mask is automatically generated by Supermax ECAD according to given design rules and is output as the second production film:



Because of the production mask requirements, all pads in a resistor must be parallel!

Deviating from this requirement is technically possible but will have an impact on the precision of the resistor as displacement of the mask will change the length of the resistor body. -The impact is dependent on the size of the resistor. By default, Supermax ECAD always create parallel resistor pads.

Many resistors need not be very accurate while others might require trimming. In other cases, a resistor is used to trim a running circuit to specifications. In these cases, the design must have testpoints/probepoints so that the resistance can be measured during trimming. The manufacturer must also have a document specifying which testpoints to use for which resistor and of course the component values. Ohmega Technologies Inc. recommend the use of IPC-D-356A test data format for this purpose.

2. Automation

2.1 set up

The resistor synthesis of Supermax ECAD is very configurable and can be used with all known embedded resistor technologies. This document will only cover issues related to the Ohmega-Ply® technology.

In order to ease introduction of Ohmega-Ply® technology, a design kit is provided free of charge. This design kit will help you with all necessary settings and tables and may be applied on top of an existing design to start using embedded resistors.

In order to synthesize a resistor, the system needs to know about the following:

1. The ohms per square unit of the resistive material.
2. The power handling per square unit of the material.
3. Minimum/maximum acceptable aspect ratio for the resistors (length/width).
4. Minimum dimensions related to required tolerances. (Larger resistors are less affected by manufacturing tolerances and are also easier to trim to value.)
5. Trim factor (Manufacturing margin to nominal resistance value to allow trimming to exact value.)
6. Layer stack up for thin film resistor material and for the resistor definition mask.
7. Resistor pad sizes and dimensions for the resistor definition mask
8. Nominal resistance value
9. Optional trim range requirement.
10. Tolerance
11. Power rating
12. Optional voltage rating

1 - 5 are resistor material related parameters. These are entered in a file named the "Resistor material file". In the design kit , the Resistor material file for all Ohmega-Ply® materials is included. It should normally not be necessary to edit the file.

6 - 7 are design specific settings. The resistor layers may be placed anywhere in the layer stack up but it is logical to place them so they closely match the actual physical board construction.

The design kit contains a technology file that when merged with an existing design, adds all the necessary layers and parameters.

8 - 12 are properties of the individual component. The properties are usually obtained through the schematic and is brought over automatically as part of the schematic integration. However, all properties may be created/edited by the layout designer.

Changing a component value will automatically update the component geometry's to fit the new conditions.

Once set up, -a process that using the design kit takes considerably less than one minute, the designer can start the synthesis process.

2.2 Defining an embedded resistor

The key to the embedded passives efficiency in Supermax ECAD is the parametric component. A parametric component is a component that will change its geometry automatically according to its component values.

Hence, to declare a resistor as being an Ohmega-Ply® resistor and not just a common discrete in a 0603 package is simply to set the component property Parametric" to the value "Resistor".

This may be done already in the schematic.

As it is very common to decide at layout level, which resistors are to be embedded, a function is provided in the menus to toggle forth and back between embedded resistor and normal discrete resistor.

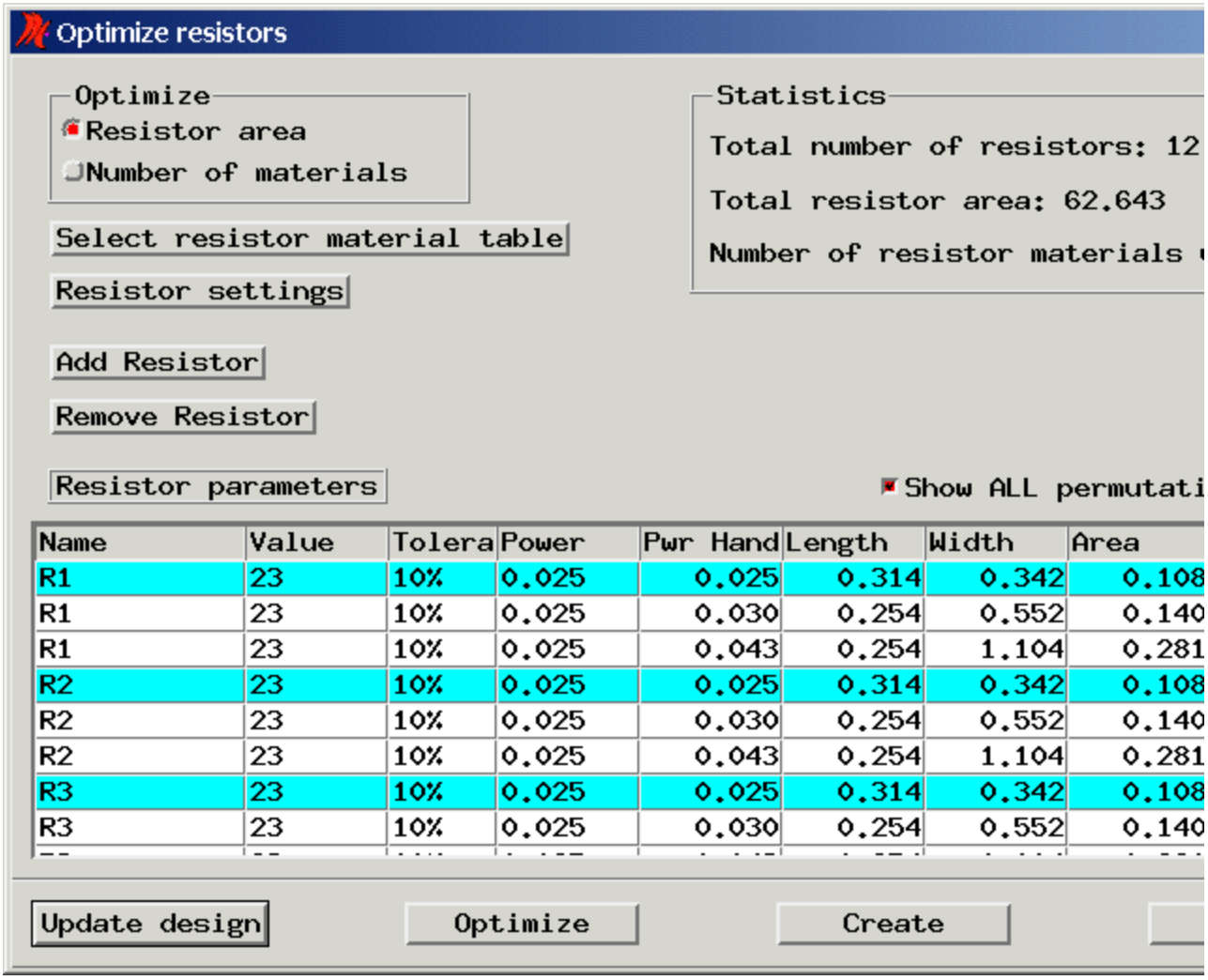
Use the menu entry Task->Embedded passives->Component synthesis->Resistors. (See picture below)

The button 'Add resistor' let you change one or many discrete resistors into embedded resistors.

The button 'Remove resistor' changes one or many embedded resistors back into discrete resistors. Original footprint name is remembered and each resistor reverts back to the footprint it originated in.

2.3 Choosing geometry and material

Once a resistor is set to be an embedded resistor, the system automatically syntheses multiple permutations of the resistor. One for each available resistance material in the set up and for each material one of each available geometry.(Rectangle, top hat, serpentine).



For each resistor the resulting power handling and dimensions are shown and the designer may choose the desired permutation by clicking in the spreadsheet or use the automatic optimization functions to optimize either on total area or by the number of resistance materials needed.

2.4 Embedded resistor handling

At this stage, the resistors may be managed in the layout tool as any other components. -Moved, rotated, auto placed etc.

The system understands the difference between the embedded resistor and other components preventing traces from being routed too close to the resistor and via holes from being punched through the resistor body enforcing correct by design.

3. Design Kit

In order to ease introduction of Ohmega-Ply® resistor technology, a design kit is provided. The kit is part of the standard distribution of the application and hence available to all users.

The kit consists of the following parts:

- **A Resistance material file** named: tables/Ohmega_resist.
  This file holds material parameters for Ohmega-Ply® 25, 50, 100 and 250 ohms per square materials.

- **A technology file** named: technologies/OhmegaPly
  This file holds layer stack up for resistor body and resistor definition mask as well as a pointer to the material file.
  It also defines layerclasses to be able to conveniently output combined layers od pads/conductors and the resistor body to Gerber and similar formats.
  Additionally, the technology holds settings for resistor pad sizes and serpentine bend rules.

- **A design guide** named ecadman/guide/OhmegaPly.html -This document

In order to use the design kit, simply open your existing design or start a new design and load the technology file using:

Task->Technology->Import.
Browse to the technology/OhmegaPly technology file and choose merge.

This will merge the necessary settings into your design making it ready for embedded resistor design.

Optionally, open settings->Layer and move the resistor and resistor definition layers to reflect the actual physical board stack up The Design example walkthrough below will give a practical example of how to execute this flow.

4. Design example walkthrough

4.1 overview

The kit contains 4 sample designs.

sampledesign1: A raw design with discrete resistors

sampledesign2: Technology OhmegaPly imported and layers placed correctly in the layer stack.

sampledesign3: Resistors R1-R8 and RT1-RT4 have been selected to be embedded resistors and been generated

Sampledesign 4: A finished design with all resistors placed and routed and manufacturing output defined.

You can start with SampleDesign1 and step wise work through the design steps or read the description opening the design at various stages.

4.2 Start

We assume that you have started Supermax ECAD.

We will start by opening the first sample design:

4.3 Open the file

Click on the file open icon. and browse for the file samples/OhmegaPly/SampleDesign1 in your Supermax ECAD installation path.

The design contains a few components of which 12 are resistors.

Each has a nominal value in their 'value' property and they also have their power rating stated.

The design is set up as a conventional 4 layer design.

4.4 Selecting the Ohmega-Ply® Design Kit

In order to set up the design for the Ohmega-Ply® technology, simply import the technology OhmegaPly

Click on Task->Technology->Import and browse for the file technologies/OhmegaPly in your Supermax ECAD installation path.

Choose Import Mode 'Merge' and click OK.

This will import the needed layers, select a resistor material file and set up all process related parameters such as resistor definition mask oversize.

Open Settings->Layer and Settings->Design Resistor and Resistor Layers to see these settings.

Note that in Settings->Layers, you see the new layers last in the layer stack up The system will function with the layers left as they are but it will make sense to move the layers to their proper place in the layer stack up. In this example, right under the TopElectric layer. Click on the arrow buttons or the position number to perform this task.

We are now ready to select which resistors we want to embed and to synthesize the resistors.

4.5 Selecting resistors for embedding

If you have performed the previous steps, you can continue with SampleDesign1.

You can also open the design SampleDesign2 where these steps has been performed.

The schematic designer can already from schematic have defined resistors as embedded by setting the component property 'Parametric' to the value 'resistor'. Otherwise, the layout designer can make the selection at layout level and that is what we will do here.

Open the dialogue Task->Embedded passives->Component Synthesis->Resistors.

To define the resistors as being embedded, click on the 'Add resistor' button. Click and drag in the list to select component R1 through RT4 and click 'Apply'

At this point, nothing visible will happen but the system now knows that all these components are to be embedded.

For each resistor it has synthesized one permutation per available material and per resistor geometry.

Resize the dialogue buy click hold and drag the bottom edge downwards. It will expose a spread sheet with resistor permutations.

Clicking on a line in the spread sheet, selects that resistor permutation and updates the layout. You can also use automatic optimization by resistor area or by number of used materials.

When you are satisfied with the result, click 'Update'.

We are now ready to place the resistors and route the connections.

4.6 Place and route

You can continue with your SampleDesign1 or you can open the design SampleDesign3 where previous steps has been performed.

Once the resistors have been synthesized, they can be placed and routed interactively or automatically.

This design guide will only briefly mention how this process is performed.

Click at the  icon. This will make the system pick components only when you click with the mouse. Now place the resistors using drag and drop with the left mouse button.

When satisfied with the placement, click at the  icon. This will make the system pick wires, vias and pins for routing.

Drag and drop the new connections in place. -Use the right mouse on a wire or via to access functions to delete a connection or segment.

In the design SampleDesign4 all resistors are placed and their connections are routed.

4.7 Editing resistors

Often resistors have to be edited. The system provides means:

1. Changing a property through the property dialogues will automatically update the resistors to for the new value. The same is true if a design update is loaded from the schematic and resistor values have changed.
2. Task->MCM/Hybrid->Resistor Edit contains the following functions to interactively manipulate a resistor:

- Move terminal. Stretch /shorten/bend a resistor keeping its nominal resistance static.
- Move terminal Stretch /shorten/bend a resistor with dynamic feedback of the resulting nominal value.
- Change width. Make a resistor body narrower or wider with dynamic feedback of the resulting nominal value.
- Add trim margin. Add a trim body with dynamic feedback of the resulting trimmable range.
- Add/Move serpentine arch with dynamic feedback of the resulting nominal value.

4.8 Generating production documents

If you have followed all the above steps you can continue with your Sample Design. As an alternative you can load the design SampleDesign4 where these steps have been performed.

Supermax ECAD contains function for fully automatic generation of all production documents.

To set up this function, go to Task->Production->CAM wizard

In the dialog, enter a suitable directory to output your production documents in. Example, C:/temp

Then click on the 'Wizard' button. The wizard prompts for a name of this production setup and suggests SampleDesign4.

We can keep this name or chose another name. Click 'Next'.

In this dialogue, we select the output formats we will use.

We will chose Gerber and IPC356. Supermax ECAD supports most common formats and for the purpose of this exercise, we bypass some operations such as drill, BOM etc.

Click 'Next'

The system will through the layer stack up try to determine the number of films needed. In this case, 8 films is suggested being:

TopPaste

TopMask

TopElectric

GndPlane

VccPlane

BottomElectric

BotMask

BotPaste

We need to add any graphical layers we need such as silk screen or assembly.

In this case, assuming that we will use only the Ohmega-Ply 25 ohms/square material, we need the TopElectric layer to be merged with the Ohmega25 layer.

The design Kit has already added a layer class named [OHM25_Combined] for this purpose.

In the matrix dialogue, change so that the third film only has a cross in the [OHM25_Combined] box.

We also need a resistor definition mask so we need one extra layer. Changing from 8 to 9 in the field at the top of the dialogue will add an extra column. In this column, add a cross for layer 'Ohmega25Mask'

Click 'Next'. -The system shows an overview of the operations. Click 'Finish'.

The dialogue shows an overview of all Gerber and IPC356 testdata generations.

Select the SampleDesign5 production and click 'Generate'

All documents should be made in few seconds and a resulting status log be displayed.

The chosen directory now contains the extended Gerber files for all production films and an IPC356 test net list and we are ready for production.

The SampleDesign5 has all the production settings in place.

5 Quick guide

1. Start with a normal design. It may be placed/routed but that is not a requirement.
2. Import the OhmegaPly technology file using Import Mode 'Merge'.
3. Move the layers to their logical places -Optional but recommended.
4. Open the dialogue Task->Embedded passives->Component Synthesis->Resistors.
   -Click 'add' and select components to be embedded.
5. Using the same dialogue, optimize on area/material and select the resistors of your choice.
   -Click update to store the settings in the design.
6. When setting up for production output, Output the copper layer merged with the resistor layer on one film and the resistor definition mask on a separate film.

6. Support

Supermax ECAD is a comprehensive layout solution designed to handle the most complex circuits in all technologies being it PCB, MCM or silicone packaging. This document only covers the Ohmega-Ply® design related issues. Further information is available in the complete system documentation found on line here: http://www.dde-eda.com/ecadman/home.html or if you have the Supermax ECAD system installed locally, here.

Our support division is happy to assist you with technical issues and can also provide on site assistance to make your technology introduction as efficient as possible.

Request Support here and you will be contacted as soon as possible.

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Top of Page