Orcad® Layout

Autoplacement User's Guide

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Before you begin

Welcome to OrCAD

OrCAD offers a total solution for your core design tasks: schematic- and VHDL-based design entry; FPGA and CPLD design synthesis; digital, analog, and mixed-signal simulation; and printed circuit board layout. What's more, OrCAD's products are a suite of applications built around an engineer's design flow—not just a collection of independently developed point tools.

How to use this guide

The *OrCAD Layout Autoplacement User's Guide* contains information about working with autoplacement in OrCAD Layout Plus. This book only includes information that is specific to autoplacement. Information that is applicable to both manual placement and autoplacement is covered in the *OrCAD Layout User's Guide.*

To help you learn and use autoplacement efficiently, this manual is separated into the following sections:

- Introducing autoplacement discusses three advanced features of autoplacement that greatly enhance component placement techniques.

- Using autoplacement discusses loading a placement strategy file and the procedures for placing components.

Symbols and conventions

OrCAD printed documentation uses a few special symbols and conventions.

Notation	Examples	Description
Ctrl+R	Press Ctrl+R	Means to hold down the Ctrl key while pressing R.
Alt, F, O	From the File menu, choose Open (Alt, F, O)	Means that you have two options. You can use the mouse to choose the Open command from the File menu, or you can press each of the keys in parentheses in order: first Alt, then F, then O.
Monospace font	In the Part Name text box, type PARAM.	Text that you type is shown in monospace font. In the example, you type the characters P, A, R, A, and M.

UPPERCASE	In Capture, open CLIPPERA.DSN.	Path and filenames are shown in uppercase. In the example, you open the design file named CLIPPERA.DSN.
Italics	In Capture, save *design_name*.DSN.	Information that you are to provide is shown in italics. In the example, you save the design with a name of your choice, but it must have an extension of .DSN.

Introducing autoplacement

1

The underlying purpose of autoplacement in Layout Plus is to intelligently enhance component placement techniques. To accomplish this, Layout Plus offers three important and advanced features: push-and-shove placement, cluster placement, and precision placement algorithms.

Push-and-shove placement

When you use the Shove command as you're placing components, Layout Plus moves components in order to clear a spot for the component you're placing.

Cluster placement

During autoplacement, Layout Plus automatically assigns each group (designated in the schematic design) to an appropriate cluster and places the components in proximity to one another on the board. As a result, the connections on a board are short, the placement has a flow to it, and the board is easier to work with.

Groups and clusters

Though they're not essential to the process, groups and clusters play an important role in autoplacement. You can group components based on their functionality or connectivity in the schematic design, or in Layout Plus using the Components spreadsheet. You can also load a strategy file that assigns component groups to clusters and places the clusters on the board, taking into account preplaced clusters and components. However you implement them, you'll find that the use of groups and clusters simplifies the placement process a great deal.

Precise placement algorithms

Layout Plus uses advanced algorithms to optimally situate components, even under severe design constraints. Because Layout Plus automatically uses these algorithms during component adjustment, proximity placement, and component swapping, it is able to consider hundreds of possible design permutations. As a result, component placement is enhanced for a wide variety of board types.

Using autoplacement

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Before you begin autoplacement, it is important to set up the board properly. Use the list below as a preplacement checklist, and ensure that these tasks are completed before you begin autoplacement.

- Check the board, place, and insertion outlines

- Check the place grid

- Check mirror layer or library layer settings

- Weight and color-code nets

- Check gate and pin data

- Check preplaced components and secure them on the board using the Lock or Fix commands

- Create component height keepins and keepouts, or group keepins and keepouts

Because these steps are the same for manual placement and autoplacement, they are described in *Preparing the board for component placement* in *Chapter 7, Placing and editing components* in the *OrCAD Layout User's Guide*.
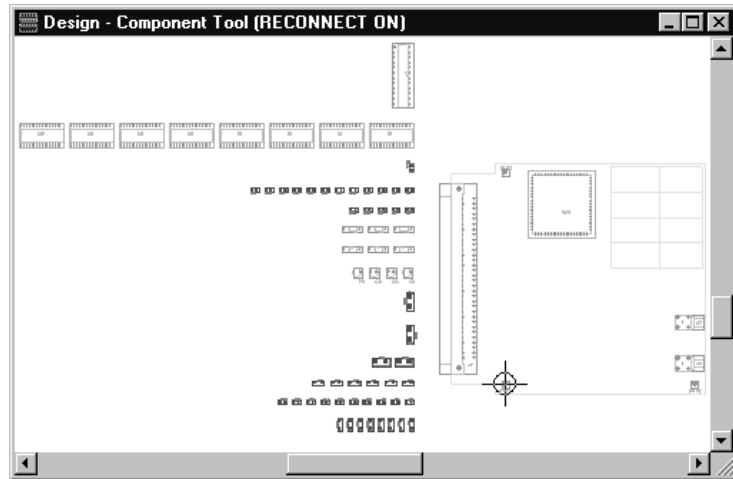
Figure 1 *A board prior to component placement.*

Once you have set up a board, you can begin placing components. You can have Layout Plus autoplace the entire board for you, you can place components in groups (using clusters), or you can place components individually.

- Autoplacement allows for a wide range of board complexity. By having Layout Plus autoplace the entire board, you can leave considerations about density and design rules to Layout Plus. This component placement method is especially suited for situations that call for an analysis of all possible board configurations.

- Grouping components in clusters lends a logic and order to the design flow of your board. Grouping with clusters minimizes connection lengths and guarantees that similar components are grouped together.

- Layout Plus makes individual component placement easier with push-and-shove technology. Activating this technology (by choosing the Shove command) moves placed components out of your way, in order to make room for the component you're trying to place.

Placing components using autoplacement

Loading a placement strategy file

A placement strategy file determines the placement of components according to various parameters that you assign. For example, you can use a placement strategy file that includes the use of gate and pin swapping and component clusters. If you're facing time constraints, you can limit the number of passes Layout Plus uses to analyze a given scenario, in order to expedite the placement process.

Using the Place Pass spreadsheet (choose the spreadsheet toolbar button, choose Strategy, then choose Place Pass), you can view the various parameters that govern the placement strategy file that is currently loaded. By changing the values of the parameters, you can create new strategy files (using an .SF extension) based on the existing strategy files.

For information on editing placement strategies, see *Editing place pass information* on page 11.

To load a placement strategy file

1   From the File menu, choose Load. The Load File dialog box displays.

2   If necessary, change Files of type to Strategy.

3   Select a placement strategy file from the files listed, then choose the Open button. Placement strategy files begin with the letters "PL."

The placement strategy files provided with Layout Plus are listed below.

PLBEST.SF

Used for the best quality placement on most boards. The completion time of the placement process is generally longer than that of PLSTD.SF, especially with complex designs.

PLCLUST.SF

Automatically creates and places clustered components. This strategy file is helpful when you have no schematic to show relationships between components. In Layout Plus, clustered components appear as unfilled circles; the diameter of each circle is directly related to the area required by the components within the cluster.

PLFAST.SF

Quickly completes component placement for simple designs. This strategy may not result in the best component placement for complex boards with numerous buses. PLFAST.SF can be used to test for potential problem spots in larger placements, to evaluate the use of differently sized, equivalent components, or to determine which side of the board to use for the placement of surface-mount components.

PLFINISH.SF

Begins where PLCLUST.SF leaves off and finishes placement using PLBEST.SF.

PLSTD.SF

Used for standard component placement. PLSTD.SF is the best choice for most boards, though it takes substantially longer to complete the placement process than PLFAST.SF. This strategy does not include gate and pin swap.

Disabling power and ground nets

During autoplacement, you are primarily concerned with connectivity between components. Because nets on plane layers are largely irrelevant to the placement process, you can disable these nets for routing. This also significantly improves system performance during placement, since disabled nets are not redrawn.

To disable nets attached to plane layers

■ Choose the spreadsheet toolbar button, then choose Nets. The Nets spreadsheet displays.

■ Using the CTRL key and the left mouse button, select all the cells in the Routing Enabled column that both pertain to nets attached to plane layers and read "Yes." Release the CTRL key.

■ From the pop-up menu, choose Enable<->Disable. The entries for the cells you selected change from "Yes" to "No," indicating that the nets are disabled.

For information on setting net properties, see *Chapter 4, Setting up the board* in the *OrCAD Layout User's Guide.*

Autoplacing components

Once the board is set up properly and you have loaded a strategy file, you can choose the Board command to automatically place all of your components. When you choose this command, Layout Plus completes six passes of component placement. The progress of the operation displays in the status bar at the bottom of your screen.

To autoplace components

1 From the Auto menu, choose Place, then choose Board.

Pass 0

Performs an initial Proximity Place pass that clusters components based on interconnectivity and then places those clusters in locations that favor shorter connections. Pass 0 uses a minimal number of iterations (repeated algorithms) and attempts (different placements attempted).

Pass 1

Performs an Assign Clusters pass that takes all of the components that are not locked or fixed and puts them in clusters according to their interconnectivity and whether the components are grouped or not.

Pass 2

Performs a Place Clusters pass that places the clusters on the board based on connectivity and their position relative to other clusters or fixed components.

Pass 3

Performs a Proximity Place pass that uses a larger number of iterations and attempts than were used in Pass 0. This process places components more accurately.

Pass 4

Performs a Swap Comps pass that swaps neighboring components to see if placement can be improved by reducing connection length and crossovers.

Pass 5

Performs an Adjust Comps pass that adjusts the components in order to eliminate any overlapping.
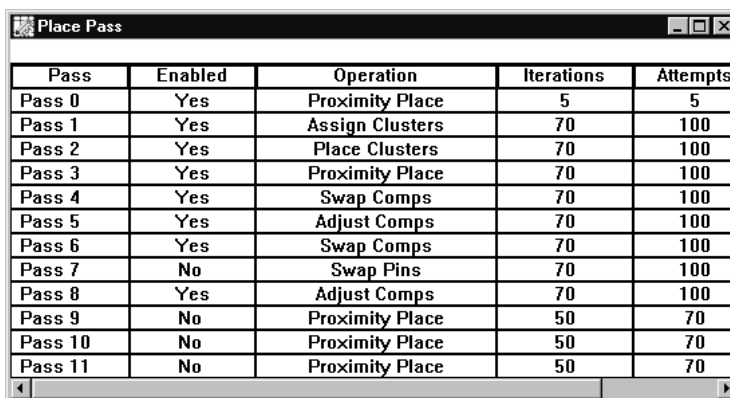
Note *After you place the board, you can view component placement
statistics using the Statistics spreadsheet. For information on
viewing component placement statistics, see Viewing placement
statistics in Chapter 7: Placing and editing components in the OrCAD
Layout User's Guide.*

Editing place pass information

Layout Plus can also perform additional passes (Pass 6
through Pass 11). Though these are disabled by default,
you can enable them in the Place Pass spreadsheet. You
can also alter the number of iterations and attempts
performed by the six standard passes, as described above.

To edit place pass information

1   Choose the spreadsheet toolbar button, choose
    Strategy, then choose Place Pass. The Place Pass
    spreadsheet displays.

Pass	Enabled	Operation	Iterations	Attempts
Pass 0	Yes	Proximity Place	5	5
Pass 1	Yes	Assign Clusters	70	100
Pass 2	Yes	Place Clusters	70	100
Pass 3	Yes	Proximity Place	70	100
Pass 4	Yes	Swap Comps	70	100
Pass 5	Yes	Adjust Comps	70	100
Pass 6	Yes	Swap Comps	70	100
Pass 7	No	Swap Pins	70	100
Pass 8	Yes	Adjust Comps	70	100
Pass 9	No	Proximity Place	50	70
Pass 10	No	Proximity Place	50	70
Pass 11	No	Proximity Place	50	70

2   Double-click in the Pass cell that corresponds to the
    pass you want to modify. The Edit Place Pass dialog
    box displays.

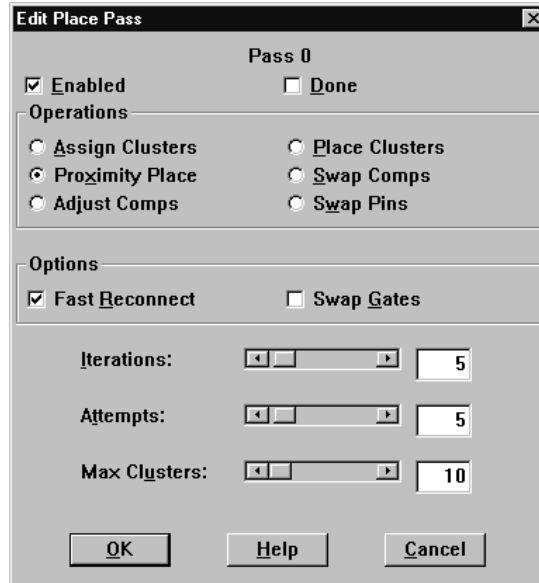3   Change the settings as desired, then choose the OK
    button.

Figure 2 *The Edit Place Pass dialog box*

Enabled

Enable passes by selecting the Enabled option. Each pass displays either a Yes or a No in the Enabled column in the Place Pass spreadsheet, indicating that the Enabled option is either selected (Yes) or not selected (No) for the pass. If you decide that a pass is not necessary, you can deselect the Enabled option for the pass, in which case the autoplacement routine does not run the pass.

Done

Tip *You can use the Done option to temporarily disable a pass, while leaving the underlying Enabled setting intact. This offers the advantage that you need only deselect the Done option, and everything will be returned to its previous state (either enabled or not enabled)*

A pass is automatically set to Done upon completion. This indicates which passes have been completed in the event that the autoplacement routine is interrupted. Once restarted, the autoplacement routine does not run any passes that are marked as Done.

Assign Clusters

Automatically groups components according to connectivity before they are placed on the board. Clusters maximize the number of connections between components within the same cluster, while minimizing the number of connections between clusters.

Proximity Place

Uses cluster locations as a starting point for board placement, then considers thousands of design permutations in order to choose a placement that optimizes quality.

Adjust Comps

After the clusters are broken, Layout Plus adjusts individual components in a rough grid pattern for a neater, more efficient placement.

Place Clusters

Places the assigned clusters in the best location on the board, relative to other clusters and fixed components.

Swap Comps

Swaps adjacent components in order to refine a nearly completed placement.

Swap Pins

Swaps pins using the package information from the schematic, to allow automatic pin swapping during autoplacement. This is not allowed if you created your board without a schematic.

Fast Reconnect

Both the Proximity Place and the Swap Comps passes automatically use this option. You can disable this option to achieve a slightly better quality placement, but at lesser speed.

Swap Gates

Swaps gates in order to reduce the overall connection length on the board.

Iterations

Controls the number of algorithms Layout Plus employs during a given placement. The higher the number, the more algorithms Layout Plus uses. A low number results in a faster placement, but a decreased chance that Layout Plus will find the right placement for the board.

Attempts

Determines how many placements are attempted during each iteration. The higher the number, the more placement attempts are made, and the better the chance that Layout Plus finds the optimum placement for the board.

Max Clusters

Specifies the maximum number of clusters that Layout Plus uses during autoplacement. It is probably best to use the default set by your placement strategy file for maximum clusters. If you choose too high of a value, autoplacement spends a great deal of time forming the clusters.

Using interactive placement commands

Layout Plus provides commands you can use to optimize placement. Using these commands, you can hide routes and connections, and shove, cluster, and adjust components to control exactly where they are placed on the board.

Hiding routes and connections

Reconnection mode prevents routes and connections from displaying on the screen, making it easier for you to see components and place them. With reconnection mode enabled, only nets connected to components you select are visible. As you move a component, its associated nets move with it, allowing you to account for connectivity while placing a component.

Tip   *If you are working with large nets, you can choose Minimize Connections from the pop-up menu while you're moving a component. The shortest route for signals associated with the component is shown.*

To hide routes and connections

1   Choose the reconnect toolbar button.

Or

1   From the Options menu, choose User Preferences. The User Preferences dialog box displays.

2   Select the Instantaneous Reconnection Mode option, then choose the OK button.

The reconnect toolbar button is "pushed in" and the phrase RECONNECT ON is added to the design window's title bar.

To re-display routes and connections

1   Choose the reconnect toolbar button.

Or

1   From the Options menu, choose User Preferences. The User Preferences dialog box displays.

2   Deselect the Instantaneous Reconnection Mode option, then choose the OK button.

The reconnect toolbar button is not "pushed in" and the phrase RECONNECT ON is removed from the design window's title bar.

Shoving components

You can use the Shove command to automatically move previously placed components so that a component you have selected and are trying to place has enough room to be placed on the board. Layout Plus uses place outlines and insertion outlines to regulate this process. Insertion outlines can overlap each other, but place outlines cannot. The direction a component is shoved is determined by the degree of overlap between the component you are trying to place and the previously placed components.

To shove components

1   Choose the component toolbar button.

2   Select a component for placement. The component attaches to your pointer.

3   As you are positioning the component, choose Shove from the pop-up menu. Layout Plus moves other components away from the component being placed.

Adjusting components

You can use the Adjust command to line up components, based on their connectivity.

Tip   *The components that you want to align should be in close proximity. This command is helpful for precise (not general) placement.*

To adjust components

1   Choose the component toolbar button.

2   Press CTRL and select two components that you want to adjust.

3   From the pop-up menu, choose Adjust. Layout Plus aligns the components.

Placing components using clusters

Clusters are component groups formed to simplify placement. As with groups, clusters allow you to move multiple components at once, can represent specific circuits, and can be placed quickly in the appropriate area of the board. Compared to a number of individual components, clusters are simple from a graphic standpoint, which makes them ideal for quickly testing various placements, since your system can redraw clusters rapidly.

When reconnection mode is enabled, a circular border represents the combined area of all of the components within a cluster. Use the circle as a visual aid that indicates the amount of room needed to place the cluster in an area of the board.

Note   *When reconnection mode is enabled, a cluster is represented by a circle. When reconnection mode is disabled, the components are individually drawn; you need only click on one component to select them all.*

Tip   *If you cannot see a cluster's circular border, your place outlines are either defined as invisible, or they are a color that is incompatible with the background color. To see a cluster's border clearly, choose the color toolbar button. In the Color spreadsheet, select the row(s) for Place outline using the CTRL key and the left mouse button. Choose Visible<->Invisible from the pop-up menu (when an entity is set to visible, its spreadsheet color displays as a solid color, not as a diagonal pattern). If the color of the place outline (the cluster's circular border) needs adjusting, assign a new color by double-clicking on the color cell for that row. A color palette displays. Select a color that will contrast well against the background color, then choose the OK button. Close the Color spreadsheet.*
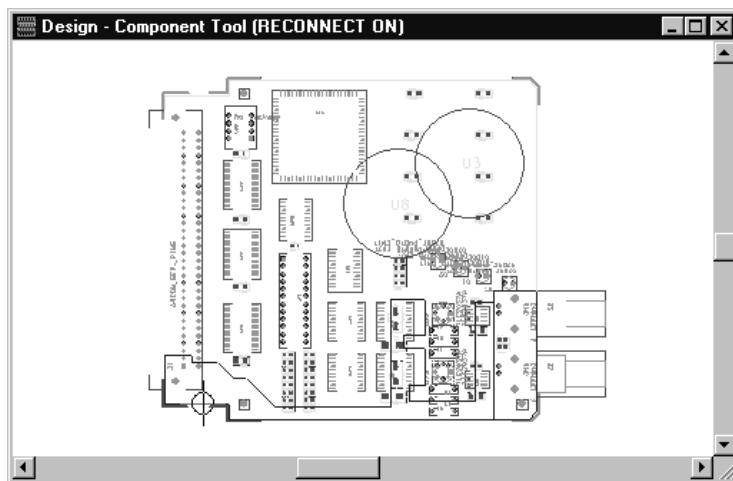
Figure 3 *U3 and U8 are clusters.*

To place components using clusters

1   Choose the component toolbar button.

2   From the pop-up menu, choose Select Any. The Component Selection Criteria dialog box displays.

3   Enter a group number in the Group Number text box and choose the OK button. You can create groups at the schematic level, or you can build them in Layout Plus.

Tip   *To group components in Layout Plus, choose the spreadsheet toolbar button, then choose Components. Select the components that you want to group by pressing CTRL and clicking the left mouse button. From the pop-up menu, choose Properties to display the Edit Component dialog box. Type an integer in the Group # text box and choose the OK button.*

4   From the pop-up menu, choose Make.

5   Position the cluster on the board and click the left mouse button to place it.

Breaking clusters

You can also use the Break command to dissolve a cluster into its individual components. Break unclusters the components, but does not change the location or parameters of any of the components within the cluster, nor does it separate the components from an assigned group.

To uncluster components

1   Choose the component toolbar button.

2   Select the cluster by pressing CTRL and clicking with the left mouse button.

3   From the pop-up menu, choose Break. The cluster is broken down into individual components.

Placing clustered components using Quick Place

After you place clusters on a board, Quick Place can unstack and arrange their components, separating them efficiently according to their place outlines.

In Layout Plus, you create a place outline by creating an obstacle, and then defining it as a place outline. For information on doing this, see Creating obstacles in Chapter 5, Creating and editing obstacles in the OrCAD Layout User's Guide.

To unpack and place clustered components using Quick Place

1   Choose the component toolbar button.

2   Select the cluster(s) by pressing CTRL and clicking with the left mouse button.

3   From the pop-up menu, choose Quick Place.

The individual components of the cluster(s) you selected are placed quickly, according to each component's place outline.

Using circular placement

Circular placement may begin with or without selecting a component. You use the Circular Placement dialog box to set up circular placement.

If a component is selected, its current footprint name, group number, location (relative distance from circle center), rotation, radius, start angle from (0,0), and component angle are included in the dialog box when you open it. If you change the values for location, rotation, radius, or angle, it causes the component to be moved or rotated. Changing the reference designator does not affect the selected component.

During circular placement, the board datum temporarily shifts to the center of the proposed circle or arc. The values in the dialog are calculated relative to this temporary datum.

When you enter values for certain options in the dialog box, Layout Plus calculates the effect of the values on other parameters within the dialog box. For example, consider a board with its circle center at 0, 0. If you set the circle's radius to 1000 mils and the Start Angle to 45 degrees, the Rel Start automatically calculates to 707.100, 707.100. These values display when you tab to another option in the dialog box, click in another field, or when you choose the OK button.

There is no error checking available to prevent component overlap. Angular values must be positive or negative values within the range of 0 to 360 degrees. Real numbers are supported, as are degrees and minutes. For example, an angle of 45.5 degrees is equivalent to 45 degrees 30 minutes, and both values are supported.

The following dialog box values are preset, based on a selected component:

- Footprint Name
- Group Number
- Circle Radius
- Start Angle
- Rel Start X, Y
- Comp Angle

If a component is not pre-selected, all dialog box values are persistent upon re-invocation of the dialog box, with the exception of Ref Des. If a component is preselected, the following dialog values are persistent upon re-invocation of the dialog box:

- Comp Count
- Angle To Fill
- Angle Between
- Comp Angle Increment
- Added Comp Angle

Note *Blank fields are not legal.*

To use circular placement

1   With no component selected, choose Circular Placement from the Auto menu. In the Circular Placement dialog box, choose the Footprint button, locate and select the footprint that you want to use for circular placement in the Select Footprint dialog box, then choose the OK button.
or
In the design window, select a component while pressing the CTRL key. From the Auto menu, choose Circular Placement. In the Circular Placement dialog box, the footprint name, group number, relative location to circle center, current rotation, current radius from circle center, current start angle from (0,0), and component angle are entered for you.

Tip *In the Select Footprint dialog box, select Local in the Libraries window to select a part from your current board file.*

2   Enter new values as desired for the dialog box options. The options are automatically calculated and updated according to the inter-relationships of their values. See *Auto-updating* in this chapter for specific information.

Note   *The Comp Count includes the selected component.*

3   Enter the number of components that you want to place in the Comp Count text box and select the Use Angle to Fill or Use Angle Between option. The Comp Angle Increment is automatically calculated, based on these entries.

Note   *Circular placement can be reversed using the Undo command only immediately after placement, but not following any subsequent commands.*

4   Choose the OK button. The components are placed according to the values specified.
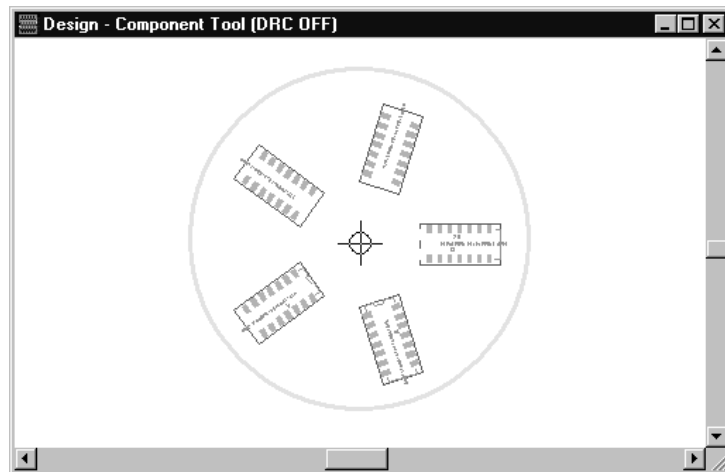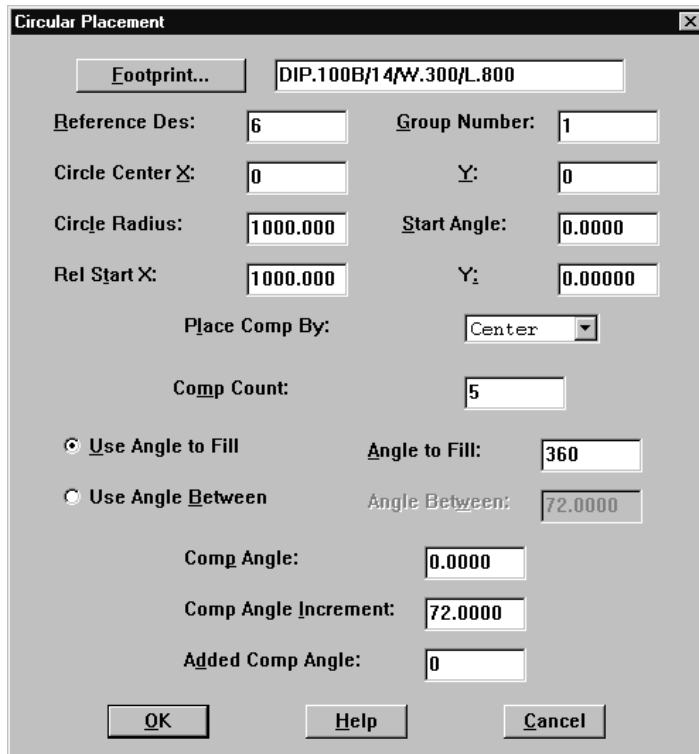
Figure 4 *The Circular Placement dialog box*

Footprint

Displays the Select Footprint dialog box, in

which you can select a library and then a footprint for circular placement.

Reference Des

The reference designator for the selected component. Default shown is the next unused reference designator for the board. Or, you may enter your own unique reference designator.

Group Number

Group number to associate with added components. The default is 0 (zero), meaning components do not belong to any group.

Circle Center X, Y

Coordinates of the circle center.

Circle Radius

Radius of the circle of placed components. The radius is measured from the circle center to the component placement point. The component is placed with its origin on this placement point.

Start Angle

Beginning placement angle of first component added or selected.

Rel Start X, Y

Placement location for first component added. This value is measured as a relative distance from the Circle Center value. If a component has been selected on the board, changing these values will cause the selected component to move and placement to begin from this new location.

Place Comp By

The drop-down list gives you choices of how the components are to be placed. Datum (the default) uses the board datum, Center uses the center of the component, Pin 1 uses pin 1 of the component, and Insert Pt uses the insertion point of the component. Regardless of how the component is placed, if it is subsequently rotated, it rotates about the datum.

Comp Count

The total number of components to be added, inclusive of a selected component.

Use Angle to Fill

Toggle button to select between Angle to Fill and Angle Between.

Angle to Fill

The angle to be filled by added components.

Use Angle Between

Toggle button to select between Angle to Fill and Angle Between.

Angle Between

The space or angle between each added component's placement point.

Comp Angle

The rotational angle of each added component. Changing this value will cause a selected component to rotate.

Comp Angle Increment

A successive rotation angle increment for each added component, calculated before placement. This will not affect a selected component; however, each added component will be rotated by this increment. For example, starting at 0, a Comp Angle Increment value of 20 degrees would cause components to be rotated before placement at 0, 20, 40, 60, and so on.

Added Comp Angle

A rotational angle that is added to each component after it is placed. This command rotates the individual components in place, around their graphic origins. For example, starting at 0, if Comp Angle Increment is 20 and Added Comp Angle is 5, the component rotations would be 5, 25, 45, 65, and so on.

Auto-updating

Certain dialog box options are automatically updated to reflect how they are affected when other dialog box values are changed. The updated values display when the focus is changed in the dialog box using the TAB key, or by clicking the left mouse button on any other item in the dialog box. They are also updated when you choose the OK button to exit the dialog box. These relationships are listed below:

- Changing Circle Center X, Y automatically updates Circle Radius, Start Angle, Rel Start X, Y, and Comp Angle.

- Nothing automatically updates Circle Center X, Y.

- Changing Circle Radius automatically updates Rel Start X, Y.

- Changing Start Angle sets Comp Angle to the same value, and automatically updates Rel Start X, Y (by default, Start Angle and Comp Angle should be the same).

Note *By default, Start Angle and Comp Angle should be the same. However, you can change Comp Angle and it will not update any other option.*

- Changing Rel Start X, Y automatically updates Circle Radius, Start Angle, and Comp Angle.

- Changing Comp Count automatically updates Angle to Fill, Angle Between, and Comp Angle Increment.

- Nothing automatically updates Comp Count.

- Changing Angle to Fill automatically updates Angle Between and Comp Angle Increment.

- Changing Angle Between sets Comp Angle Increment to the same value and automatically updates Angle to Fill.

Note *By default, Angle Between and Comp Angle Increment should be the same. However, you can change Comp Angle Increment and it will not automatically update anything else.*

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