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Preface

Congratulations on choosing Ultiroute from Electronics Workbench. We are confident that it will deliver years of increased productivity and superior designs.

Electronics Workbench is the world's leading supplier of circuit design tools. Our products are used by more customers than those of any other EDA vendor, so we are sure you will be pleased with the value delivered by Ultiroute, and any other Electronics Workbench products you may select.

About this Manual

This manual applies to all versions of Ultiroute. Functions that are available only in some versions are clearly marked.

Manual Conventions

For the purposes of illustration, all images in this manual are shown with black lines on a white background. In the product itself, screens show colored lines on a black background.

This manual uses the convention **Menu/Item** to indicate menu commands. For example, **File/Open** means choose the **Open** command from the **File** menu.

The contents of this manual are also available as a PDF file (called `Ultiroute_guide.pdf`). On-line help is also available — use the **Help** menu to invoke it.

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Introduction

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Chapter 1
Introduction

1.1 About this Chapter

This chapter introduces you to Ultiroute, the advanced autorouting and autoplacement tool from Electronics Workbench. Ultiroute interfaces with and is accessed from Ultiboard, the leading PCB layout product, also from Electronics Workbench.

1.2 What is Ultiroute?

Ultiroute offers advanced autoplacement with state-of-the-art autorouting for optimal layout of your printed circuit boards. Please note that autoplacement is not included with all versions of Ultiroute (for example, the Personal Edition).

Ultiroute, once installed, is accessed from within Ultiboard, as explained in “Loading a Design from Ultiboard” on page 3-1. Ultiroute does not place a separate icon on your desktop for Ultiroute.

Ultiroute’s success is due, in part, to its unique application of a combined grid and gridless autorouting algorithm. The routing engine routes on a grid, where possible, but automatically switches to gridless autorouting when necessary. This gives you all the benefits of gridless autorouting for traces that are difficult to route, with the convenience of having most traces located on grids for easy and efficient manipulation.

Please note that Ultiroute operates on a preset number of PCB layers; the exact number depends upon the version of Ultiroute you purchased.

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Introduction

1.3 About Combined Grid/Gridless Autorouting

Ultiroute supports placement of parts and traces both on and off the grid. Parts and traces placed off the grid in Ultiboard remain off the grid in Ultiroute. Parts placed by Ultiroute itself during autoplacing are placed only on the grid. Traces placed by Ultiroute during autorouting are normally placed on the grid, with automatic switching to gridless as necessary.

1.4 Installing Ultiroute

The CD-ROM you received for Ultiroute is self-starting. Follow the directions below and those on the screen during the installation process.

Note If you received Ultiboard and Ultiroute together, you *must* install Ultiboard first. To install Ultiboard, see the installation instructions in the Ultiboard *Getting Started* manual included in the Ultiboard product box.

Note Your software has been issued with a dongle. When prompted during the installation process, insert the dongle into your computer's parallel port.

➢ To install Ultiroute:

1. Exit all Windows applications.
2. Insert the Ultiroute CD into your CD-ROM drive. When the Ultiroute GT Setup screen appears, click **Next** to continue.
3. Read the License Agreement, which can also be found in the front of this manual. You must accept the conditions of the License Agreement before continuing. To accept the agreement, and to continue on to the next screen, click **Yes**. If you do not accept the terms of the agreement, click **No** and the Ultiroute installation will be terminated.
4. You are now prompted to install the dongle you received with Ultiroute into the parallel port located in the back of your computer.

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Please note: some versions of Ultiboard require a dongle. If your version of Ultiboard was shipped with and requires a dongle, it should still be attached to the parallel port of your computer. Remove and discard it. Insert the dongle provided in this package, which allows both Ultiboard and Ultiroute to operate.

Once you have installed the Ultiroute dongle, click **Next** to continue.

5. In the screen that appears, enter your name and company name. Click **Next** to continue.
6. You are now prompted to choose the location in which you want Ultiroute to be installed. Ultiroute must be installed in the same folder as Ultiboard in order for it to operate. This is the default configuration displayed. Select **Next** to accept the installation location and to continue.
7. In the space provided, enter the serial number you received with your software. Your serial number is located on a label on the back of the CD case. Click **Next** to continue.

Ultiroute will now finish being installed. If for any reason you wish to stop the installation, click **Cancel** and the installation of Ultiroute will be terminated.

Note Once Ultiroute is installed, the dongle provided with it is required for any operation of Ultiboard or Ultiroute.

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Chapter 2
User Interface

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Chapter 2
User Interface

2.1 About this Chapter

This chapter provides an overview of the overall Ultiroute user interface and a reference to Ultiroute's menus and commands.

To get started with Ultiroute, we suggest you briefly review Section 2.2 below, then go directly to the "Getting Started" chapter. The remainder of this chapter, comprised of Section 2.3.1 through Section 2.3.9, explains the functions accessed through the Ultiroute menus and is normally used as a reference. When you wish information on a particular menu item, or you are searching for information on how to do something in Ultiroute, you can always come back to this chapter.

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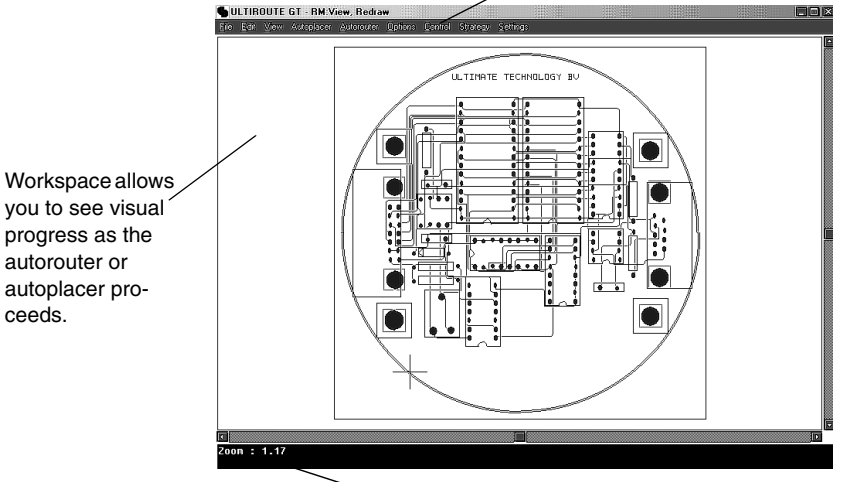
2.2 About the Ultiroute User Interface

The Ultiroute interface consists of a main workspace, the menu system located above the workspace, and a combination status/command line located below the workspace.



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2.3 Menus and Commands

2.3.1 File Menu

2.3.1.1 File/Save

Use to save the routed or partially routed design. The program saves the design in a file called `baewin.dat`. When you exit or close the program, Ultiroute automatically asks if you want to use the contents of this file in Ultiboard.

You can also use this command to back up your work.

2.3.1.2 File/Exit

Use to exit Ultiroute. If you have changed the routing or component placement of your board, you are prompted to save these changes.

2.3.2 Edit Menu

2.3.2.1 Edit/Undo

Use to undo a component, via, or trace placement. You may undo an unlimited number of operations.

2.3.2.2 Edit/Redo

Use to redo any changes to your board made with the **Edit/Undo** command. You may redo an unlimited number of operations.

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2.3.3 View Menu

2.3.3.1 View/Redraw

Use to redraw the current design.

2.3.3.2 View/Zoom All

Use to display the board at full screen magnification.

2.3.3.3 View/Zoom Last

Use to display the board at the previous magnification.

2.3.3.4 View/Zoom Out

Use to reduce the magnification of the board.

2.3.3.5 View/Zoom Window

Use to magnify a selected part of the board. Ultiroute prompts you to click the opposite corners of a rectangular area on the board, and then zooms in on that section.

2.3.3.6 View/Centre/Pan Window

Use to reposition a point on your board to the center of your workspace. Click on the point you want to move to the center of the viewing area.

2.3.3.7 View/Zoom to PCB Border

Use to zoom in as much as possible while still keeping the entire board on the screen. Lets you zoom so that the border of the board touches the edges of the screen.

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2.3.4 Autoplacer Menu

2.3.4.1 Autoplacer/Full Autoplacer

Use to do a fully automatic component placement.

When doing a full autoplace, Ultiroute uses placement parameters you define with the **Autoplacer** menu's **Part Pin Factor**, **Segment Fit**, **Mirroring Mode**, **Rotation Mode**, **Part Expansion**, and **Number of Retries** commands.

For more on this command, see "Full Autoplacer" on page 4-6.

2.3.4.2 Autoplacer/Cluster Autoplacer

Use to place the first component manually.

After choosing **Autoplacer/Cluster Autoplacer**, click the location within the board outline where you want to place the first component. Ultiroute then places the remaining components according to the placement parameters you define using the **Autoplacer** menu's **Part Pin Factor**, **Segment Fit**, **Mirroring Mode**, **Rotation Mode**, **Part Expansion**, and **Number of Retries** commands.

For more on this command, see "Cluster Placer" on page 4-7.

2.3.4.3 Autoplacer/Area Placer

Use to determine whether or not all the components can be placed on the board successfully.

Do not use as a substitute for the **Full Autoplacer** or **Cluster Autoplacer** commands, as the area placer does not optimize component placement for optimal routability.

For more on this command, see "Estimating Spacing Requirements — Area Placer" on page 4-3.

2.3.4.4 Autoplacer/Unplace Components

Use to remove placed components from the board prior to placing them again.

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The **Unplace Components** command removes all previously placed components, with the exception of those placed and locked in the circuit design prior to importing your design from Ultiboard.

2.3.4.5 Autoplacer/Single Pass Optimization

Use to perform a single pass part optimization of a board, while performing automatic pin and gate swaps to minimize connection lengths for the autorouter.

For more on this command, see “Setting Autoplacement Passes” on page 4-7.

2.3.4.6 Autoplacer/Multiple Pass Optimization

Use to perform multiple passes optimization of a board, while performing automatic pin and gate swaps to minimize connection lengths for the autorouter.

For more on this command, see “Setting Autoplacement Passes” on page 4-7.

2.3.4.7 Autoplacer/Part Pin Factor

Use to set the weighting that determines the placement priority for components during autoplacment. This is called the part pin factor.

The part pin factor can be any whole number or decimal value between 0 and 1.

If you set the value to 0, the autoplacer first places components that have the highest *absolute number* of connections to the parts that are already placed.

If you set the value to 1, the autoplacer first places components that have the *greatest proportion* of their total pins connected to the parts that are already placed.

A value between 0 and 1 weights the placement criteria accordingly. When prompted, type the appropriate pin count weight in the command line and press ENTER. For example:

```
Zoom : 1.17
Pin Count Weight [0.0,1.0] (0.10) ?
```

For more on this command, see “Controlling Cluster Placement” on page 4-5.

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2.3.4.8 Autoplacer/Segment Fit

Use to control the extent to which Ultiroute places parts of similar length beside each other. The segment fit factor can be any whole number or decimal value between 0 and 1. This is called the segment fit factor.

If you set the value to 0, the autoplacer will not place parts with similar lengths beside each other.

If you set the value to 1, the autoplacer will place parts with similar lengths beside each other whenever possible.

A value between 0 and 1 weights the placement criteria accordingly. When prompted, type the segment fit value you want, and press ENTER. For example:

```
Zoom : 1.17
Segment Fit [0.0,1.0] (1.00) ?
```

For more on this command, see “Aligning Parts” on page 4-8.

2.3.4.9 Autoplacer/Mirroring Mode

Use to select single or double-sided component placement.

Mirroring mode may allow full placement of a set of components that do not fit on one side of the board.

For more on this command, see “Placing Components on the Underside of the Board” on page 4-10.

2.3.4.10 Autoplacer/Rotation Mode

Use to allow Ultiroute to rotate components as they are placed.

In many cases, rotated components may fit onto the board more efficiently than unrotated components.

For more on this command, see “Part Rotation” on page 4-11.

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2.3.4.11 Autoplacer/Part Expansion

Use to set the spacing between components.

The **Part Expansion** command allows you to increase component spacing on low density boards and decrease spacing on high density boards. In the case of low density boards, increasing the part expansion factor may improve routability and manufacturing yields.

When prompted, type the part expansion value you want and press ENTER. For example:

```
Zoom : 1.17
Expansion Value ( 0.00mil) ?
```

For more on this command, see “Setting Part Spacing” on page 4-12.

2.3.4.12 Autoplacer/Number of Retries

Use to specify the number of passes the autoplacer uses to improve component placement after a successful initial placement.

2.3.4.13 Autoplacer/Pin/Gate Swap Passes

Use to set the number of passes when swapping pins and gates to achieve shorter connections.

2.3.4.14 Autoplacer/Pin/Gate Swap Method

Use to enable the various swap options. The swap options are as follows:

Only part swap	Allows swapping between functionally equivalent parts.
Only pin/gate swap	Allows swapping between functionally equivalent pins and gates on a single part.
Both swap methods	Allows both of the above.
No swap	No swaps allowed.

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2.3.5 Autorouter Menu

2.3.5.1 Autorouter/Full Autorouter

Use to do a fully automatic routing of your board.

Note All board components must be in place before you can use the **Full Autorouter** command.

For more on this command, see “Running all the Routing Functions Together” on page 5-6.

2.3.5.2 Autorouter/Optimizer

Use to eliminate unnecessary vias and smooth wire bends. Use also to route any remaining open connections.

2.3.5.3 Autorouter/Batch Setup

Use to select and sequence any of the autorouter’s individual functions. Use a batch routine as an alternative to the **Full Autorouter** command.

For more on this command, see “Running the Routing Functions Separately” on page 5-7.

2.3.5.4 Autorouter/Batch Start

Use to execute a a user-defined sequence of autorouter functions created with the **Batch Setup** command.

2.3.5.5 Autorouter/Route Single Net

Use to route a single net. After choosing **Route Single Net,** click on a pin whose net you would like routed.

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2.3.5.6 Autorouter/Route Single Part

Use to autoroute a single part. After choosing **Route Single Part**, click on the part that you want autorouted.

2.3.5.7 Autorouter/Place and Route

Use to place your components and route the board fully automatically.

The **Place and Route** command combines the functions of the **Full Autoplacer** and **Full Autorouter** commands.

2.3.6 Options Menu

2.3.6.1 Options/Maximum Via Count

Use to set the maximum allowable number of vias per trace. For more on this command, see “Maximum Vias Per Trace” on page 6-1.

2.3.6.2 Options/Via Grid

Use to switch the via grid on or off, and to specify the grid size. For more on this command, see “Via Grid” on page 6-2.

2.3.6.3 Options/Routing Sub-Grid

Use to specify half-grid routing. For more on this command, see “Routing Off Grid” on page 6-2.

2.3.6.4 Options/Gridless Routing

Use to specify whether Ultiroute uses grid-based or gridless routing.

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2.3.6.5 Options/Traces On-Grid

Use to set the trace corner cutting mode. For more on this command, see “Trace Corner Cutting Mode” on page 6-3.

2.3.6.6 Options/Pin Contact Mode

Use to determine whether or not Ultiroute allows pin corner routing. For more on this command, see “Pin Contact Mode” on page 6-4.

2.3.7 Control Menu

2.3.7.1 Control/Optimizer Passes

Use to prepare the board for manufacturing by eliminating unnecessary vias, smoothing wire bends, and routing any remaining open connections. For more on this command, see “Optimizer Passes” on page 6-4.

2.3.7.2 Control/Router Cleanup

Use to activate cleaning passes during rip-up and retry routing. Cleanup employs a unique pattern search recognition algorithm for identifying “problem” traces. For more on this command, see “Router and Optimizer Cleanup” on page 6-5.

2.3.7.3 Control/Optimizer Cleanup

Use to activate cleaning passes during optimization routing. Cleanup employs a unique pattern search recognition algorithm for identifying “problem” traces. For more on this command, see “Router and Optimizer Cleanup” on page 6-5.

2.3.7.4 Control/Rip-Up Trees

Use to set the maximum number of traces allowed to be simultaneously ripped up per rip-up cycle. For more on this command, see “Rip-up Trees, Depth, and Retries” on page 6-6.

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2.3.7.5 Control/Rip-Up Depth

Use to control the persistence of the rip-up processor more on this command, see “Rip-up Trees, Depth, and Retries” on page 6-6.

2.3.7.6 Control/Rip-Up Retries

Use to set the maximum number of rip-up retries for routing a particular trace. For more on this command, see “Rip-up Trees, Depth, and Retries” on page 6-6.

2.3.7.7 Control/SMD Via Pre-Place

Use to create fanouts for SMD parts. This function, when activated, generates short trace connections from SMD pads to vias. By creating these short connections to vias (which can connect to any layer), you are increasing the router’s ability to make connections to the SMD pads (which only connect to one outside layer).

For more on this command, see “SMD Via Preplace” on page 6-7.

2.3.7.8 Control/Router Pin/Gate Swap

Use to enable pin/gate swap while routing to swap equivalent pins/gates that result in more optimal trace connections. For more on this command, see “Router Pin/Gate Swap” on page 6-8.

2.3.7.9 Control/Security Copy

Activate to create file backups of intermediate routing results. For more on this command, see “Security Copy” on page 6-8.

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2.3.8 Strategy Menu

2.3.8.1 Strategy/Optimization Direction

Use to set the routing direction during optimization. You can choose to follow the pre-defined layer specific directions, always use 45 degrees routing where possible, or ignore routing directions altogether. For more on this command, see “Optimize Direction” on page 6-10.

2.3.8.2 Strategy/Cost Factors

Use to control the relative “costs” for different strategies when routing. For more on this command, see “Cost Factors” on page 6-10.

2.3.9 Settings Menu

2.3.9.1 Settings/Autosave

Use to set the internal time between autosaves.

2.3.9.2 Settings/Reset Parameters

Use to reset most options to their default settings.

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Chapter 3
Getting Started

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Getting Started

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Chapter 3
Getting Started

3.1 About this Chapter

This chapter explains how to perform commonly used functions to set up Ultiroute.

3.2 Loading a Design from Ultiboard

Any design created in Ultiboard, the leading PCB layout tool also from Electronics Workbench, is easily imported into Ultiroute.

➢ To import a design:

1. Open the design in Ultiboard.
2. Choose **Autoroute/ULTIroute**. When Ultiroute launches, the design you created in Ultiboard loads into Ultiroute automatically.

Design rules for autorouting your boards are set in Ultiboard before you transfer your designs to Ultiroute, but can be overridden in Ultiroute. The design class chosen in Ultiroute will affect the Ultiboard file.

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3.3 Passing Parameters from Ultiboard to Ultiroute

3.3.1 Production Classes

Ultiboard makes it easy for you to design your PCB for the production class of your choice because it uses predefined design rules for each of the supported production classes. Ultiboard also warns you if you use trace sizes or pad sizes that require a higher (and more expensive) production class.

Ultiboard is preconfigured with design rule settings for the four production classes used most commonly in PCB manufacturing. The production classes that Ultiboard supports are:

Class 3M — used for easy designs

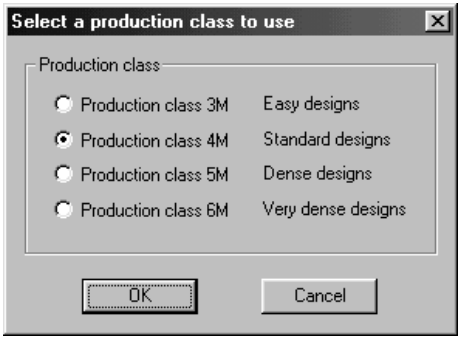
Class 4M — used for standard designs

Class 5M — used for dense designs

Class 6M — used for very dense designs

Ultiboard uses Production Class 4M design rules by default because it is the most common class, and most PCB manufacturers are able to manufacture boards to this class. This class is also well suited for prototype boards.

When you send a design file from Ultiboard to Ultiroute, you are prompted to choose a production class.



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Choose one of the four production classes to specify the design rules Ultiroute should use. These classes correspond to design rule combinations frequently handled and recommended by manufacturers. Ultiroute replaces the values set in Ultiboard with those from one of the production classes, as summarized in the table below:

	Class 3M (easy)	Class 4M (standard)	Class 5M (dense)	Class 6M (very dense)
Trace width (code 1)	12.5	10	8.3	6.25
Trace clearance	11.5	9	7.3	5.2
Pad width (code 1)	60	50	58.3	60
Pad clearance	11.5	9	7.3	5.2
Component grid	50	20	50	50
Routing grid	25	20 (10*)	16.67	12.5 (6.25*)
Via width	40	35	28	22
Hole size	23.33 (0.6mm)	19.69 (0.5mm)	15.74 (0.4mm)	11.67 (0.3mm)

*Sub-grid

Note The settings built into the class definitions replace all settings saved in the original circuit design. This is done to get the best results with Ultiroute.

3.3.2 Routing Grid

When choosing a production class, consider the effect of its associated grid value. It is important to select a production class with a routing grid appropriate for your design.

In general, Ultiroute has more success routing traces on a small grid because finer placement is possible. As a result, off-grid pin placement is less likely (for example, when Ultiroute goes off-grid to connect a trace to an off-grid pad) and the routing engine can operate more quickly and efficiently than if a large grid is

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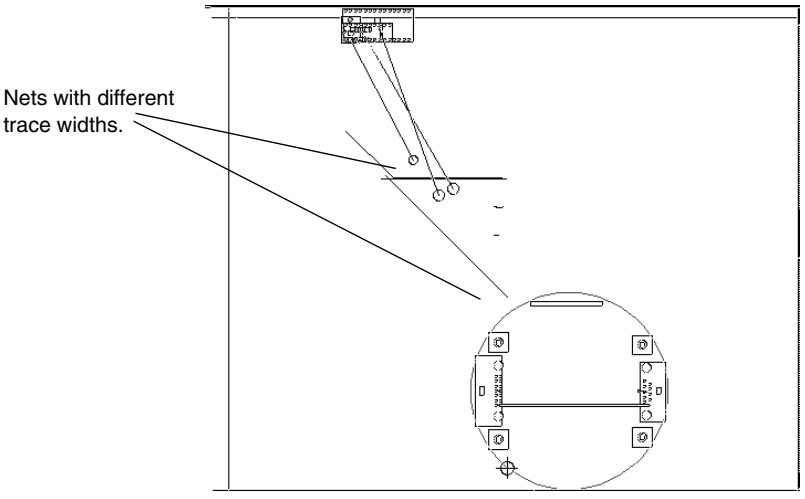
used. In addition, a small grid makes it more likely that Ultiroute can route between pin channels.

On the other hand, the smaller the routing grid, the longer it will take to autoroute a board. Any reductions in grid size cause quadratic increases to the memory requirements of Ultiroute's routing matrix. Furthermore, small routing grids increase the number of different possible ways to route the traces. This raises the processing demands on the CPU and increases routing time considerably.

3.3.3 Trace Widths

Use Ultiboard to assign different trace widths to different nets. Ultiroute will adhere to the trace widths you have specified in Ultiboard. The following example of a board shows nets with different trace widths.



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3.3.4 Setting Active Routing Layers

You can set the layers on which you want Ultiroute to place traces using **Autoroute/Settings** in Ultiboard. See *Ultiboard User Guide* for more information.

3.3.5 Setting Layer Routing Directions

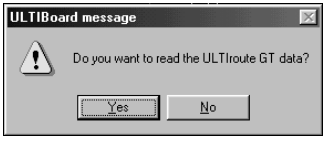
You can set the layer routing directions using **Autoroute/Settings** in Ultiboard. The settings are then transferred to the Ultiroute router. See *Ultiboard User Guide* for more information.

3.4 Transferring a Design Back to Ultiboard

Once you are finished using Ultiroute for autorouting and/or autoplacing, you will want to transfer your design back to Ultiboard.

➢ To transfer a design back to Ultiboard:

1. From Ultiroute, choose **File/Save** to save your changes.
2. Choose **File/Exit** to close Ultiroute. Ultiboard automatically displays the following screen:



3. Click **Yes** if you would like your routing results to be automatically loaded into Ultiboard.

Note If you do not first save your file, you will be asked if you want to save your changes when you choose **File/Exit**.

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Return to Presentation

Chapter 4
Autoplacement of Parts

Return to Presentation

Autoplacement

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Chapter 4
Autoplacement of Parts

Note Autoplacement is not available in Ultiroute Personal Edition.

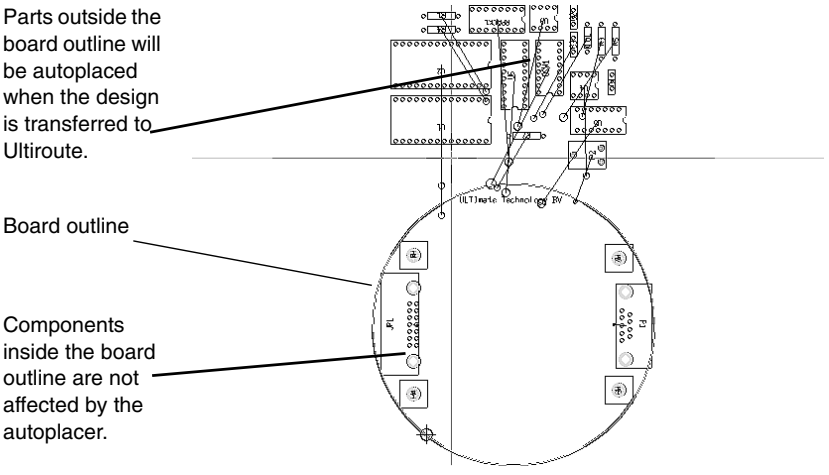
4.1 About this Chapter

This chapter explains how to use the Ultiroute autoplacer to place parts.

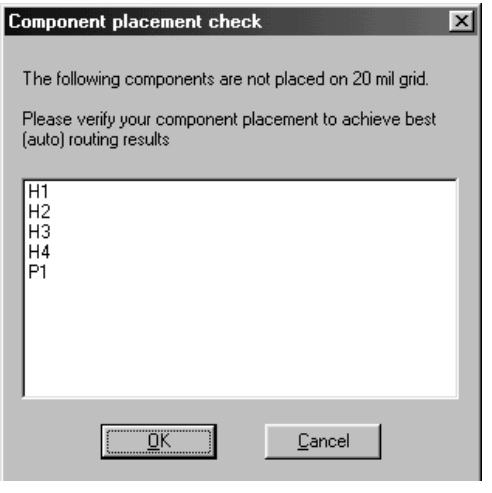
4.2 Pre-Placing Parts

If you want to place parts so they will not be moved by the autoplacer, place them within the board outline in Ultiboard before transferring the design. The autoplacer only places components left outside the board outline.

Once your design is transferred to Ultiroute, you can make pre-placed parts available to the autoplacer by choosing **Autoplacer/Unplace Components**. To pre-place components so that they *cannot* be unplaced, use the lock command in Ultiboard to lock the components before you transfer your design to Ultiroute.



When you choose **Autoroute/ULTIroute** in Ultiboard to call the Ultiroute application, Ultiroute performs a component placement check to determine if any of the components were not placed on the grid size you selected. A part that has been placed off-grid can present problems. Ultiroute reports on components that were not placed on the grid size you selected in Ultiboard, as shown in this example:



While you get better routing results if all components are placed on-grid, Ultiroute supports off-grid placement.

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4.3 Estimating Spacing Requirements — Area Placer

The area placer gives you a quick estimate of whether or not there is sufficient space on your board to autoplace all parts. When placing components, the area placer algorithm only considers the shape of the parts—it does not consider which placement is best from a functional perspective. For this reason, use the area placer only to determine if the parts can be placed successfully by the autoplacer. Since the area placer does not necessarily place parts with common connections close together, the resulting placement will probably not produce optimal autorouting results.

➢ To use the area placer:

1. Choose **Autoplacer/Area Placer**.
2. Click on the place within the board outline where you want to begin placing components. Ultiroute will attempt to place the components contained in your design, using the selected point as the starting point.
   - If the placement is successful, Ultiroute arranges all components within the board outline and returns a status line message that the operation is complete. Before you proceed to the autorouting stage, it is recommended you perform an autoplacement, as the area placer may not produce optimal autorouting results.
   - If the placement is not successful, Ultiroute does a partial placement and returns a status line message indicating how many parts were not placed. The placement may have been unsuccessful because your board is not of sufficient size/shape to hold all of your parts.

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4.4 Understanding How the Autoplacer Works

The autoplacer automatically places all unplaced parts onto your board according to a group of settings you can specify. It uses a rip-up and retry algorithm to iteratively find the best component positioning. As the autoplacer runs, the status line at the bottom of the screen indicates how many autoplacement passes have been completed. The status line also indicates how many components have been placed and how many pins have been swapped (when the autoplacer performs pin/gate swaps). If the autoplacer cannot place all the parts, it returns a message indicating how many parts are still unplaced.

The autoplacer places components as clusters. These clusters are generated by grouping a multi-pin component with a series of connected components, each of which has fewer than four pins. Each cluster is then assigned a placement priority. By arranging parts into clusters judiciously, the autoplacer can place together those parts that have multiple connections. Block capacitors, which are connected to power signals, are always excluded from clusters. Using automatic block capacitor recognition, Ultiroute places block capacitors close to their corresponding ICs.

Tip Parts and part clusters are assigned and processed in alphabetical order according to part names. You can control the placement priority of your ICs by naming them alphabetically in the order you want them placed.

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4.5 Running the Autoplacer

4.5.1 Controlling Cluster Placement

The **Part Pin Factor** command is used to control cluster placement. When determining which part should be placed next, the cluster placer looks for a part that has many connections to parts that have been already placed. This part can be either the one with the *most* pins or with the *greatest percentage* of pins connected to parts that have already been placed. You determine which condition is used by specify a pin count factor. A pin count factor of 0 prioritizes components with the highest absolute number of pin connections. In contrast, a pin count factor of 1 prioritizes components with the highest ratio of connections to total pins. The default part pin factor is 0.1.

➢ To set the part pin weight:

1. Choose **Autoplacer/Part Pin Factor**.
2. In the command line, type any value from 0 to 1 and press ENTER. Ultiroute confirms that the new value is accepted.

Note A high part pin factor value usually result in a better distribution of nets than a low factor value. However, high values may cause excessive placement area fragmentation on high-density layouts by placing small parts prematurely and preventing you from placing larger ones later on.

4.5.2 Choosing A Placement Start Location

You can control how the autoplacer selects the placement location for the first component. Since the first placement affects where Ultiroute places all subsequent parts, your choice of where the first part should go affects the autoplacement results considerably. If you do not achieve 100 percent completion or are not satisfied with the autoplacement results using a particular start location, you can experiment with different start locations. If the first part cannot be placed at the start point you choose, the autoplacer cannot place any subsequent parts.

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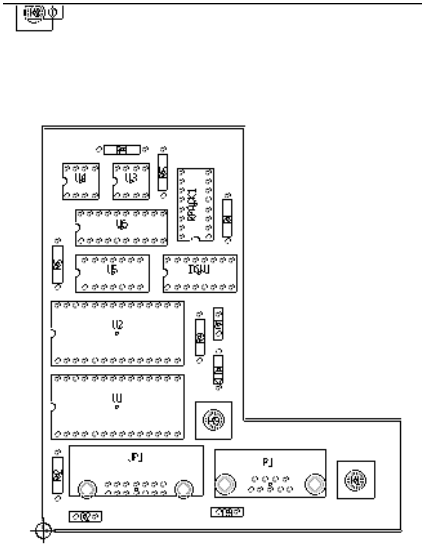
Your choices are to let Ultiroute define the starting point (full autoplacer) or to define the starting point yourself (cluster placer).

4.5.2.1 Full Autoplacer

The full autoplacer uses the gravity point of the board outline as the location for the first placement. Ultiroute calculates the board's imagined centre of gravity—the point at which the board is perfectly balanced.

Certain boards (for example, L-shaped boards) may have gravity points beyond their outlines. For cases in which the board's gravity point falls outside its outline, use cluster or area placement. If you run the full autoplacer on an L-shaped board, you will not be able to place any parts. Components in the following example of an L-shaped board were placed using cluster placement.



➢ To use full autoplacement, choose **Autoplacer/Full Autoplacer**. As the autoplacer runs, it displays its progress in the status line. If the placement is successful, Ultiroute arranges all components within the board outline and returns a status line message that the operation is complete.

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4.5.2.2 Cluster Placer

The cluster placer is similar to the autoplacer, except that it lets you specify the placement position for the first component.

➢ To use the cluster placer:

1. Choose **Autoplacer/Cluster Placer**.
2. Click on the location within the board outline where you want to begin placing components. Ultiroute will attempt to place the components.
   - If the placement is successful, Ultiroute arranges all components within the board outline and returns a status line message indicating that the operation is complete.
   - If the placement is not successful, Ultiroute attempts a partial placement and returns a status line message indicating how many parts were not placed.

4.5.3 Setting Autoplacement Passes

You can specify the number of passes the autoplacer uses to improve component placement. After an initial placement, the autorouter runs the number of rip-up and retry passes you choose (between 0 and 99). The default value is 2.

➢ To set the number of autoplacement passes:

1. Choose **Autoplacer/Pin/Number of Retries**.
2. In the command line, type any value from 1 to 99 and press ENTER. Ultiroute confirms that the new value is accepted.

You may now run the autoplacer with the new pass settings.

Note While a small number of rip-up and retry passes can improve your board layout, too many passes can make the layout less efficient. An excessive number of passes can separate block capacitors from their ICs and small components from the clusters to which they were originally assigned. Furthermore, a large number of autoplacer passages requires a relatively large amount of processor time.

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4.5.4 Aligning Parts

Use the segment fit option to control the extent to which the autoplacer puts components with equal lengths side by side. Placing parts with similar lengths beside each other results in neater and more professional looking board layouts. It may also improve the routability of the board by aligning the components with bus connections. However, for high density boards with few bus connections, aligning parts with similar lengths will not necessarily produce better routing results.

A segment fit value of 0 indicates no segment fit preference. In contrast, a segment fit value of 1 indicates a strong preference for aligning parts with equal edge lengths. The default value is 1.

➢ To set the segment fit value:

1. Choose **Autoplacer/Segment Fit**.
2. In the command line, type any whole number or decimal value from 0 to 1 and press ENTER. Ultiroute confirms that the new value is accepted.

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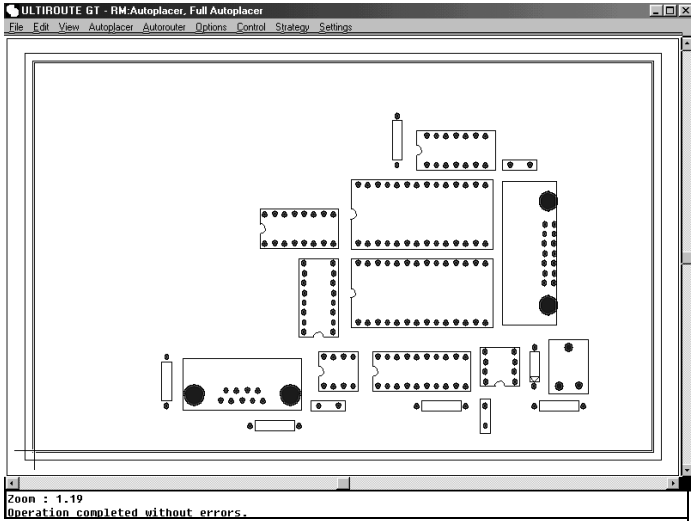
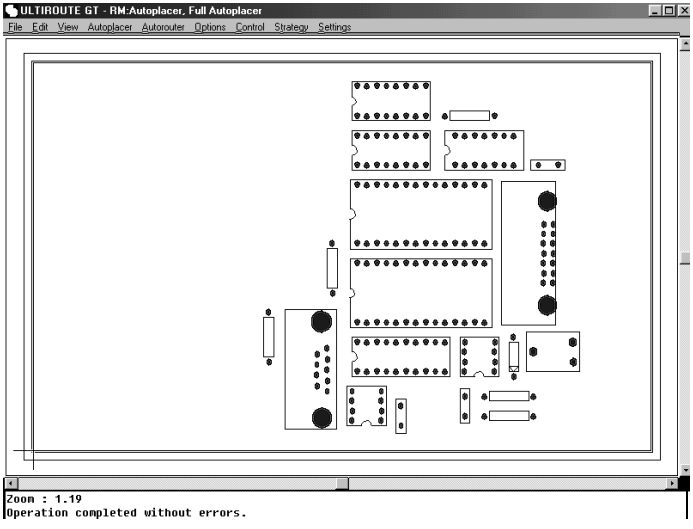
You may now run the autorouter with the new segment fit settings. The effect of different segment fit values on component values can be seen by looking at these two examples.

Component placement with segment fit value set to 0.



Component placement with segment fit value set to 1.



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4.5.5 Placing Components on the Underside of the Board

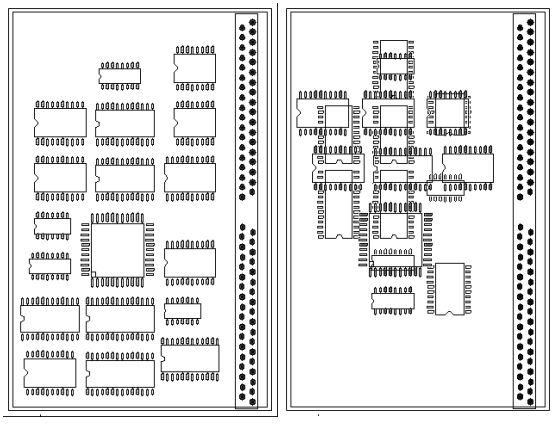
Ultiroute allows you to place surface mounted devices (SMDs) on both the top and bottom sides of a board and relax the part spacing. Use the component mirroring function to place SMDs on both the "parts" and the "solder" sides of your boards.

➢ To enable component mirroring:

1. Choose **Autoplacer/Mirroring Mode**.
2. From the sub-menu, choose one of the following commands:
   - **No SMD Mirroring** — components are placed on the top side of the board only
   - **SMD Mirroring** — components are placed on both sides of the board.

You may now run the autoplacer with the new mirroring settings. If the results are not what you expected, you can use **Edit/Undo** or **Autoplacer/Unplace Components** to make changes. Component placements done with SMD mirroring can look significantly different from component placements done without mirroring, as the examples below illustrate:

SMD mirroring OFF. All component pins are displayed in a single color.



SMD mirroring ON. Pin color depends on component location. Top of board = One color
Bottom of board = A different color.

Note Before designing a board with mirrored SMDs, make sure your manufacturer can support component placement on the bottom of the board.

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4.5.6 Part Rotation

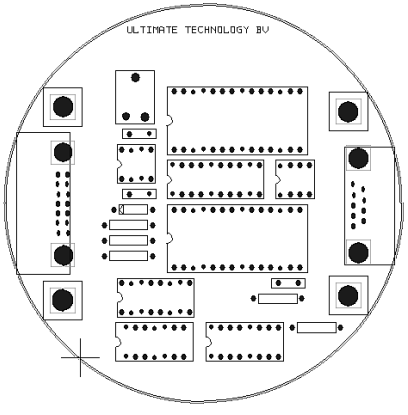
The part rotation settings determine how much Ultiroute is able to rotate components when placing them. In general, when you restrict part rotation, you simplify your component placement, consume less CPU time, and create a layout that is easy to change later. However, when you choose unrestricted part rotation, you may end up with a much more efficient board layout than you would get with no part rotation.

➢ To change the part rotation settings:

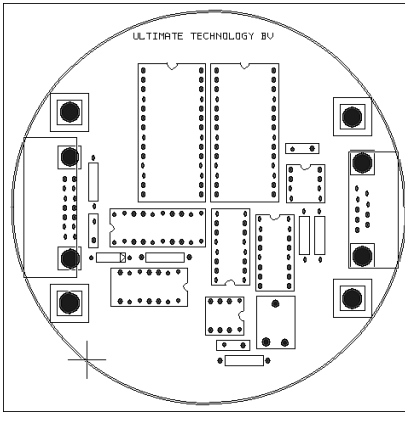
1. Choose **Autoplacer/Rotation Mode**.
2. From the sub-menu, choose one of the following commands:
   - **0-90 Degree Rotation** — permits 90 degree, clockwise rotation
   - **0-270 Degree Rotation** — permits any kind of rotation
   - **0 Degree Rotation** — does not permit any rotation
   - **90 Degree Rotation** — all parts rotate by 90 degrees

Here is an example of two component placements using different part rotation settings:

Rotation mode set to 0 degrees rotation. Components are placed in their original orientation.



Rotation mode set to 0-270 degree rotation. Components are rotated before placement for maximum layout efficiency.



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4.5.7 Setting Part Spacing

Ultiroute gives you full control over the spacing that the autoplacer leaves between components. This allows you the flexibility of reducing the part spacing on dense boards and increasing the part spacing on low-density boards. By default, Ultiroute sets the part spacing value to 0mm.

➢ To change the part spacing:

1. Choose **Autoplacer/Part Expansion**.
2. In the command line, type any whole number or decimal value of 0.00mm or greater and press ENTER. Ultiroute confirms that the new value is accepted.

Note On low density boards, you can spread parts evenly by increasing the part spacing. In general, this increases the trace lengths on your board. However, it also improves your board's routability and increases manufacturing yields. Use small part spacing when creating prototypes, and larger spacing for production runs.

4.5.8 Achieving 100% Part Completion

Occasionally, the autoplacer is unable to place all the components in a design. In this case, you may wish to try one or more of the following:

- Reduce the placement grid.

  Change the board's production class to one with a smaller placement grid than the one you are currently using. This gives the autorouter more discrete points on which it can place parts.

- Reduce the part spacing.

  As part expansion values get larger, the area in which the autoplacer can place components gets smaller. Reducing the part spacing allows the autoplacer to pack parts more densely.

- Use unrestricted part rotation.

  If you restrict part rotation, the autoplacer is not able to reorient the parts for the most efficient fit on the board. Use a less restrictive rotation mode setting to allow Ultiroute to reorient the parts as necessary.

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- Allow SMD mirroring.

  Allow Ultiroute to place components on both sides of the board. This doubles the area on which the autoplacer can arrange parts, and eases the space requirements on the top side of the board.

- Choose a different placement start location.

  The autoplacer yields different results depending on where you tell it to place the first component. Choosing a different start location may help the autoplacer achieve 100 percent completion.

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Chapter 5
Autorouting

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Autorouting

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Chapter 5
Autorouting

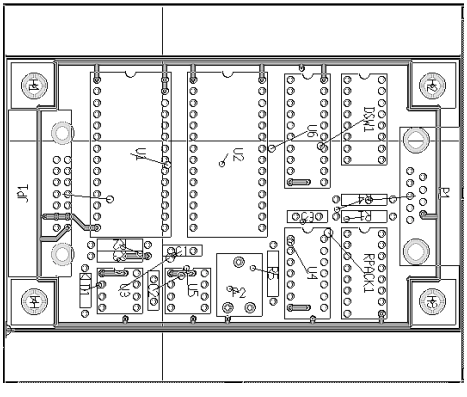
5.1 About this Chapter

This chapter explains how to perform the available autorouting functions, and how to monitor and customize autorouting performance.

5.2 Pre-Placing Traces

Ultiroute gives you the option of pre-placing traces before running the autorouter. These traces may be placed on or off the grid. Pre-placed traces cannot be changed by the autorouter, as shown in the following examples.

VCC and GND connections are pre-routed.



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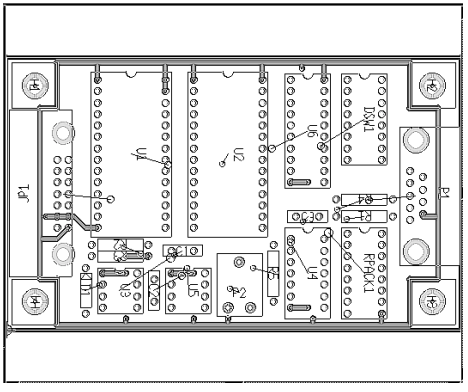
The autorouter routes the rest of the connections, but the nets remain unchanged.



5.3 Understanding How the Autorouter Works

Ultiroute contains four fundamental routing functions:

- SMD via preplacement
- initial routing
- rip-up and retry passes
- optimization.

Ultiroute uses combinations of these functions to route a board. These fundamental routing functions are described in “Understanding the Four Fundamental Routing Functions” on page 5-3. Information on how to use these capabilities can be found in “Running the Autorouter” on page 5-6.

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5.4 Understanding the Four Fundamental Routing Functions

This section describes the four fundamental routing functions used by Ultiroute.

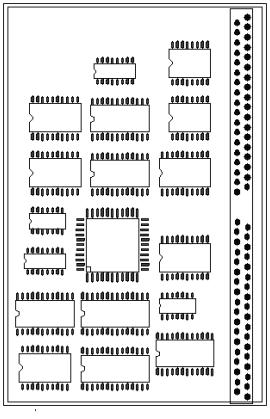
5.4.1 SMD Via Preplacement (Fanout)

The SMD via preplacement function routes short escape wires from SMD pads to open areas on the board. Routing to SMD pins is difficult because the pins are densely packed and the pin pads are connected only to the top or bottom layer of the board.

Ultiroute creates fanout vias to make connections between difficult-to-reach SMD points and locations just outside the pin array of the SMD. These locations outside the SMD's pin array are more practical for the autorouter to reach than the SMD pins themselves.

To see how Ultiroute creates fanout vias, consider the following example of a board with components already placed.

This board has already had its components autoplaced.



Preplaced connections to SMD pins are not changed by the SMD via preplacement.

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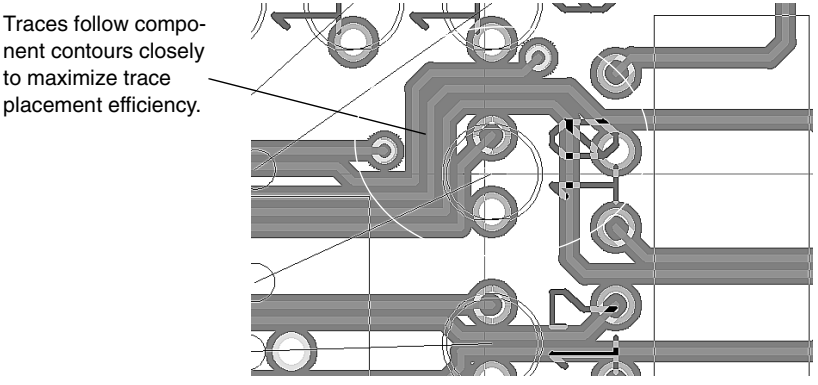
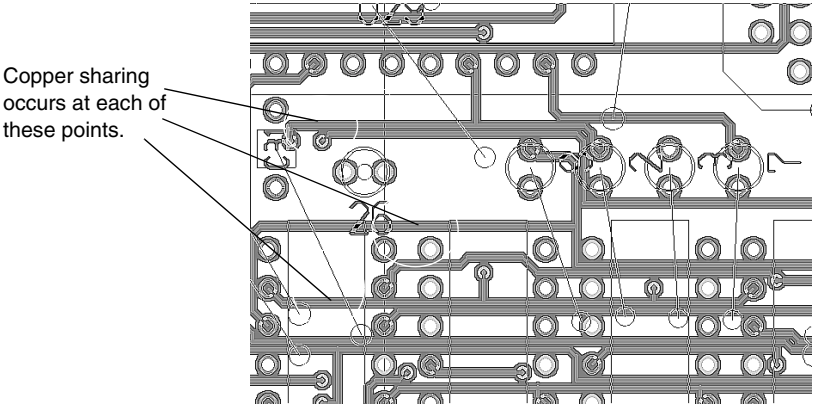
5.4.2 Initial Routing

Initial routing automatically routes as many traces as possible in a single pass without any rip-up and retry operations. Ultiroute uses trace hugging to place traces as close together as possible, and close to obstacles. This leaves more room in open areas to route other traces. An example of trace hugging is seen here:



Ultiroute also uses copper sharing where appropriate. The T-junctions shown below are examples of copper sharing:



You can run initial routing in two different modes: single-pass and complete.

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5.4.2.1 Single-Pass Initial Routing

This mode runs a single routing pass only, and finishes when it either achieves 100 percent completion or cannot route any more connections without ripping up existing traces.

5.4.2.2 Complete Initial Routing

This mode runs four routing passes to route as many traces as possible without ripping up and retrying any trace. With each consecutive pass, the autorouter reduces the channel width and increases the allowable via count.

5.4.3 Rip-up and Retry Routing

The rip-up and retry router attempts to route all open connections. In some cases, Ultiroute can place all traces in a single pass without rerouting any traces. However, if Ultiroute does not achieve 100 percent completion, then the rip-up and retry router rips up selected traces and reroutes them to make room for other traces that could not be placed during the first pass.

The rip-up and retry router is guarded by a backtracking algorithm, which not only prevents routing deterioration or deadlock during rip-up and optimization, but is able to exploit better routing solutions. The rip-up and retry router automatically activates an intermediate optimizer if a single rip-up pass does not achieve 100 percent routing success. You can prevent Ultiroute from calling the optimizer by selecting **Control/Router Cleanup/Rip-up Cleanup Off**.

Part of Ultiroute's rip-up and retry procedure is to analyze dense board areas and adopt routing strategies in these areas, which increase manufacturing costs. The cost factors Ultiroute uses can be adapted to your current routing problem; thus, you can control the routing strategies that Ultiroute uses and keep production costs within acceptable limits. It is strongly recommended that you do not modify these routing strategies unless you achieved poorer routing results than you expected. When changing cost factors, even slight adjustments can have large effects on routing success, either improving or worsening the results. Cost factors are explained in "Cost Factors" on page 6-10.

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5.4.4 Optimization

The optimizer is usually applied after the autorouter achieves 100 per cent completion. The optimizer eliminates unnecessary vias and smooths wire bends to reduce manufacturing costs. It also routes any remaining open connections.

5.5 Running the Autorouter

5.5.1 Running all the Routing Functions Together

The **Full Autorouter** command runs an end-to-end autorouting process that includes all four routing functions, applied in the following order:

1. SMD via placement
2. initial routing
3. rip-up and retry passes
4. optimization.

Note Ultiroute does not perform SMD via preplacement if the via preplace option is switched off.

➢ To do a full autoroute, choose **Autorouter/Full Autorouter**.

Ultiroute begins routing your board and displays its progress in the status line. When the process is complete, the status line indicates whether or not the board was successfully routed and displays the total elapsed routing time.

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5.5.2 Running the Routing Functions Separately

Ultiroute's batch routing function allows you to perform any of the four fundamental routing functions in any order you choose. You can schedule up to ten procedures as part of a batch. These procedures are run sequentially.

➢ To create a batch:

1. Choose **Autorouter/Batch Setup**. Ultiroute displays a pop-up list with 10 fields, all of which are empty by default.

2. To add a procedure to the batch list, choose the first available field. A command line prompt appears.
3. In the command line, type the batch code for the first procedure you want to run:

L	load layout (not normally used since design files are always loaded automatically from Ultiboard)
F	full autorouter
I	single-pass initial routing
S	SMD via preplacement
C	complete (multi-pass) initial routing
R	rip-up and retry
O	optimizer
-	delete a procedure

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4. Press ENTER. Depending on the procedure you are adding to the batch, you may be prompted for more information in the command line:
   - If you chose **I**, type a value (0 - 999) for the initial pass channel width and press ENTER. Then type a value (0 - 999) for the maximum via count per route and press ENTER again.
   - If you chose **S**, type a value (0 - 999) for the initial pass channel width and press ENTER.
   - If you chose **O**, type a value (0 - 999) for the number of optimizer passes and press ENTER.
5. Repeat steps 1-4 for each additional process you want to add to the batch list. When the batch is fully defined, choose **No Change** to close the batch list.

➢ To run the batch you defined, choose **Autorouter/Batch Start**.

Ultiroute runs the batch and displays the progress in the status line.

➢ For example, to use the batch list to perform SMD via preplacement:

1. Choose **Autorouter/Batch Setup**. Ultiroute displays a pop-up list with 10 fields, all of which are empty by default.

2. Choose **1** to define the first of ten possible batch operations. Type “S” in the command line to specify SMD via preplacement and press ENTER.
3. When Ultiroute prompts you for an initial pass channel width, type “1” and press ENTER.
4. Choose **No Change** in the batch pop-up list to close it.

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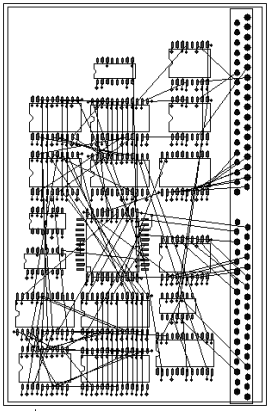
5. Choose **Autorouter/Batch Start** to run the batch. Ultiroute lays out the SMD vias as seen here:



5.5.3 Running Autorouting and Autoplacement Together

The **Autorouter/Place and Route** command combines the functions of the **Full Autoplacer** and **Full Autorouter** commands.

Use the **Autorouter/Place and Route** command to place your components and route the board fully automatically.

For more information on the **Full Autoplacer** command, see “Full Autoplacer” on page 4-6.

For more information on the **Full Autorouter** command, see “Running all the Routing Functions Together” on page 5-6.

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Chapter 6
Controlling the Autorouter

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Autorouter

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Chapter 6
Controlling the Autorouter

6.1 About this Chapter

This chapter explains how to use some of the more advanced features of Ultiroute. The information provided is intended for users who require additional information about how to control the autorouter to further customize its operation to improve the results.

6.2 Design Rules and Technology Requirements

Ultiroute provides many design rule and technology requirement options for your boards, as described in this section.

6.2.1 Maximum Vias Per Trace

Use the **Maximum Via Count** command to set the maximum allowable number of vias per trace. The default number is 20. Ultiroute lets you change the maximum via count between different router passes without requiring you to restart the entire routing process.

- To set the maximum via count:
  1. Click **Options/Maximum Via Count**. A command line prompt appears.

```
Zoom : 1.17
Maximum Via Count per Route : 20 (0..99) ?
```

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2. Type a via count value between 0 and 99 and press ENTER. Ultiroute confirms that the new value is accepted.

Note When you reduce the maximum via count between routing passes, Ultiroute reduces the number of vias per trace only if reducing the number of vias does not cause layout deterioration. Reducing the maximum vias per trace between successive routing passes reduces the number of actual vias only as much as possible without making the routing results worse.

Tip To route boards without using any vias, set the maximum via count per route number to zero.

6.2.2 Via Grid

Use the **Via Grid** command to set the grid size for via placement. You may change the via grid between different router passes without restarting the routing process from the beginning.

➢ To set the via grid size:

1. Click **Options/Via Grid**.
2. From the sub-menu, choose one of the following commands:
   - **No Grid** — allows unrestricted via placement corresponding to the current routing grid settings. This is the default option.
   - **100 mil** — places vias on a 100 mil grid.
   - **50 mil** — places vias on a 50 mil grid.

Note If you change the via grid size between router passes, Ultiroute adjusts via placement of existing vias only if this does not cause layout deterioration.

6.2.3 Routing Off Grid

Use the **Routing Sub-Grid** command to allow half-grid routing. When half-grid routing is active, Ultiroute routes along half grid points to complete difficult connections in dense pin arrays. For example, if the routing grid is 20 mils and all grid points are occupied by pins, the router will place some traces on a 10 mil grid.

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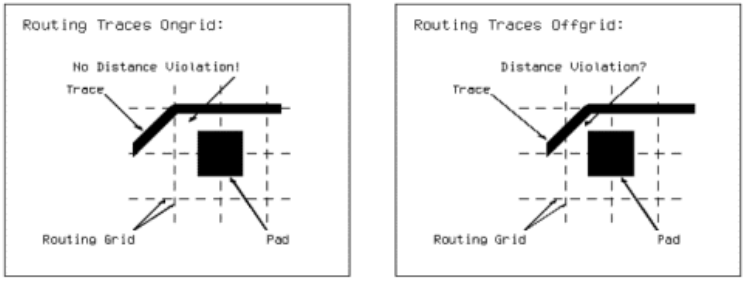
➢ To use half-grid routing:

1. Choose **Options/Routing Sub-Grid**.
2. From the sub-menu, choose one of the following commands:
   - **Standard 1:1** — disables off-grid routing. This is the default option.
   - **Half-grid 1:2** — enables off-grid routing.

6.2.4 Trace Corner Cutting Mode

Use the **Traces On-Grid** command to determine whether or not Ultiroute can place a trace corner off-grid. You can see the difference between on- and off-grid trace placement in the diagram below.



In general, placing trace corners off-grid results in efficient use of limited board space. However, it may also create distance violations by cutting traces too close to the corner of a pad.

➢ To set off-grid corner placement for traces:

1. Choose **Options/Traces On-Grid**.
2. From the sub-menu, choose one of the following commands:
   - **Traces Off-Grid** — enables off-grid corner placement
   - **Traces On-Grid** — disables off-grid corner placement. This is the default option.

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6.2.5 Pin Contact Mode

Use the **Pin Contact Mode** command to determine whether or not Ultiroute allows pin corner routing. Pin corner routing is a method of connecting to the corner of a rectangular pad using a 45 degree entry angle. In some cases, this can improve the routability of your board.

➢ To set the pin contact mode:

1. Click **Options/Pin Contact Mode**.
2. From the sub-menu, choose one of the following commands:
   - **Use Pin Corners** — enable pin corner routing. This is the default option.
   - **Lock Pin Corners** — disable pin corner routing.

Note In cases in which pin size is equal to or smaller than the trace size, pin corner routing may fail. It is not advisable to use pin corner routing for designs that contain thick traces.

6.3 Controlling the Four Basic Routing Functions

6.3.1 Optimizer Passes

Use the **Optimizer Passes** command to set the number of optimizer passes that are automatically activated after the autorouter achieves 100 percent completion. The default number of passes is 3.

➢ To set the number of optimizer passes:

1. Click **Control/Optimizer Passes**. A command line prompt appears.

```
Zoom : 1.17
Optimizer Passes : 3 (1..99) ?
```

2. Type an optimizer pass value between 1 and 99 and press ENTER. Ultiroute confirms that the new value is accepted.

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6.3.2 Router and Optimizer Cleanup

Use the **Router Cleanup** and **Optimizer Cleanup** commands to enable or disable cleanup passes after routing and rip-up. During the cleanup passes, Ultiroute uses a unique search recognition algorithm to identify and remove "problem" traces, those that are deteriorating overall routing results. Running cross-net optimization with cleanup enabled requires more computing time than optimization without cleanup, but significantly reduces via counts. For this reason, the cleanup function is called automatically if the rip-up router cannot achieve 100 percent completion.

- To enable router cleanup:
  1. Click **Control/Router Cleanup**.
  2. From the sub-menu, choose one of the following commands:
     - **Rip-Up Cleanup Off** — disables rip-up cleanup.
     - **Rip-Up Cleanup Standard** — enables rip-up cleanup. This is the default option.
- To enable optimizer cleanup:
  1. Click **Control/Optimizer Cleanup**.
  2. From the sub-menu, choose one of the following commands:
     - **Optimization Cleanup Off** — disables optimization cleanup.
     - **Optimization Cleanup Standard** — enables optimization cleanup. This is the default option.

Note Cleanup should not be disabled when routing or optimizing a dense board. Turning the cleanup function off results in sequential processing of the connections, and may cause contending results when running the final optimizer pass.

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6.3.3 Rip-up Trees, Depth, and Retries

The **Rip-Up Trees** command sets the maximum number of traces that can be ripped up during each rip-up cycle. The default value is 2.

The **Rip-Up Depth** command controls the persistence of the rip-up process. The higher the value you set, the greater the persistence each rip-up cycle has. The default value is 50.

The **Rip-Up Retries** command sets the maximum number of rip-up retries for each trace. The higher the number of retries you set, the greater the rip-up intensity in each trace. The default value is 2.

- To set the maximum number of traces that can be ripped up during each rip-up cycle:
  1. Click **Control/Rip-Up Trees**. A command line prompt appears.

     ```
     Zoom : 1.17
     Maximum Rip-Up Trees : 2 (1..9) ?
     ```

  2. Type a number between 1 and 9 and press ENTER. Ultiroute confirms that the new value is accepted.
- To set the persistence of the rip-up:
  1. Click **Control/Rip-Up Depth**. A command line prompt appears.

     ```
     Zoom : 1.17
     Maximum Rip-Up Deepth : 50 (1..999) ?
     ```

  2. Type a value between 1 and 999 and press ENTER. Ultiroute confirms that the new number is accepted.

In general, high rip-up control values increase the persistence and intensity of the rip-up and routing process. Thus, high values are especially useful for special tasks—such as achieving 100 percent completion without intermediate router passes or routability checks.

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6.3.4 SMD Via Preplace

Use the **SMD Via Pre-Place** command to enable or disable the initial routing algorithm that connects SMD pins to inside layers of the board. When via pre-placing is active, the autorouter function begins by, wherever possible, generating short trace connections between vias and any SMD pins that are to be wired. Via pre-placing prevents the autorouter from overusing the SMD outside layers in the early stages of the routing process, and accelerates successful routing in a wide range of SMD designs.

➢ To turn SMD via preplacement on or off:

1. Choose **Control/SMD Via Pre-Place**.
2. From the sub-menu, choose one of the following commands:
   - **Via Pre-Place Off** — disables SMD via pre-placement.
   - **Via Pre-Place On** — enables SMD via pre-placement. This is the default option.

Note Ultiroute does not pre-place vias on SMD pins that are already connected to fixed traces. Any redundant SMD via connections created in the pre-placement process are removed by the optimizer later in the routing process.

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6.3.5 Router Pin/Gate Swap

Use to enable pin/gate swap while routing to swap equivalent pins/gates that result in more optimal trace connections.

The pin and gate swap feature depends on the contents of the pkg.dat and $pkg.dat files. Ultiboard scans these files and collects swap information for all components in the design. This information is stored in the device (.dvc) file. The pin and gate swap feature is based on the components' value property. For swapping to work correctly, all components must have the correct value property assigned (they can not be empty).

When making pin connections at the schematic level, you choose the pin and gate connections which produce the most aesthetically pleasing, easy-to-read schematic diagram. At the PCB layout level, switching functionally equivalent pin and gate connections can often making routing easier.

Some, but not all, components will allow swapping. A pin swap exchanges pins with identical functionality. A gate swap exchanges gates with identical functionality. Ultiboard allows you to choose between different levels and methods of swapping. See *Ultiboard User Guide* for more information.

6.3.6 Security Copy

When enabled, the security copy feature saves backups of intermediate routing results automatically.

➢ To enable or disable the security copy function:

1. Choose **Control/Security Copy**.
2. From the sub-menu, choose one of the following commands:
   - **Security Copy Off** — disables the automatic backup. This is the default option.
   - **Security Copy On** — enables the automatic backup.

6.4 Trace Routing Strategy

Ultiroute lets you specify the direction of routing optimization and the cost factors allocated with routing. The table below summarizes each strategy parameter and states whether changes to these parameters affect the router, the optimizer, or both.

Strategy Parameter	Value Range	Default Value	Affects Router?	Affects Optimizer?
Optimize direction	Normal Preferred Diagonal	Normal	No	Yes
Via Cost	2-20	10	Yes	Yes
Pin Channel Cost	0-10	3	Yes	No
Counter Direction Cost	0-5	1	Yes	Yes
Change Direction Cost	0-5	2	No	Yes
Packing Cost	0-5	1	Yes	No
Dynamic Density Cost	0-50	10	Yes	No
Bus Bending Cost	0-5	2	Yes	No
Distance-1 Cost	0-10	5	Yes	No
Distance-2 Cost	0-10	2	Yes	No
Trace Crossing Cost	2-100	20	Yes	Yes
Diagonal Cost	0-10	5	No	Yes
Off-Grid Cost	0-5	2	Yes	Yes

Note The numbers shown in “Value Range” and “Default Value” above are simply used for relational purposes and have no real-world meaning, that is, they do not indicate the number of cents it “costs” to increase the number of vias.

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6.4.1 Optimize Direction

➢ To specify the optimizer strategy:

1. Choose **Strategy/Optimization Direction**.
2. From the sub-menu, choose one of the following commands:
   - **Normal** — instructs the optimizer to ignore layer-specific preferred routing directions to keep the number of vias to a minimum. This is the default option.
   - **Preferred** — instructs the optimizer to consider layer-specific preferred routing directions. This may increase the number of vias on your board.
   - **Diagonal** — instructs the optimizer to prefer 45 degree routing where appropriate.

6.4.2 Cost Factors

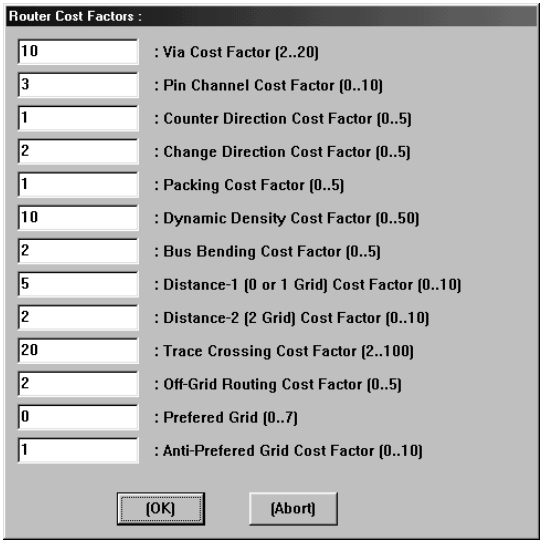
You may adjust cost factor settings to control how the router "prices" its various routing strategies.

The default values are chosen carefully to give you the best balance of routing characteristics, except in exceptional circumstances. In general, leave the cost factors at their default values unless the autorouter is not producing the results you want. Any adjustments that are not carefully considered can actually worsen autorouter performance.

Therefore, if you decide to change cost factors, adjust no more than *two* cost factor variables at a time and make your changes in small increments. Large adjustments to many variables will almost certainly cause poor results. Also remember that many variables share strong mutual dependencies. For example, any increase in via placing costs compromises the router's ability to route using preferred directions.

➢ To change cost factors:

1. Choose **Strategy/Cost Factors**. The Router Cost Factors screen appears.



2. Edit one or more of the following fields:

- **Via Cost Factor** — a high via cost factor results in fewer vias than a low via cost factor, but also results in relatively complex circuit traces. A low via cost factor permits the router to place vias up to the maximum number you specified with the **Maximum Via Count** command. (See “Maximum Vias Per Trace” on page 6-1.)
- **Pin Channel Cost Factor** — a high pin channel cost factor results in infrequent use of pin channels, the regions between adjacent part pins. A low value allows frequent use of pin channels.
- **Counter Direction Cost Factor** — a high counter direction cost factor forces a strict adherence to the layer-specific preferred routing directions, while a low factor permits frequent deviations from the preferred direction.
- **Change Direction Cost Factor** — a high direction cost factor limits the number of trace corners the optimizer creates. A low factor allows frequent changes in routing direction.
- **Packing Cost Factor** — a high packing cost factor instructs the router to bundle circuit traces wherever possible. A low factor results in a wider distribution of circuit traces across the board.

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- **Dynamic Density Cost Factor** — controls the global distribution of traces. A high dynamic density cost factor explicitly tries to create an even or wide distribution of traces across the board, rather than letting the other costs determine how traces should be placed. A low factor lets trace distribution be determined by routing cost.
- **Bus Bending Cost Factor** — controls the bending of traces after they pass through a pin channel. A high bus bending cost factor results in frequent bus bending, while a low factor results in infrequent bus bending.
- **Distance-1** — controls the use of channels left by ripped-up traces in the near distance (0-1 grid point, trace-to-trace). A high distance-1 factor results in infrequent use of these channels, forcing relatively more local changes during rip-up and retry routing. A low factor permits the router to use these channels freely.
- **Distance-2** — controls the use of channels left by ripped-up traces in the far distance (2 or more grid points, trace-to-trace). A high distance-2 factor results in infrequent use of these channels, forcing relatively more global changes during rip-up and retry routing.
- **Trace Crossing Cost Factor** — sets the trace transition cost factor, which the router and optimizer use to control cleanup pattern recognition during multi-net optimization. A high trace crossing cost factor permits complex routing with many traces crossing each other. This creates a relatively large number of vias. A low factor leads to more intensive and time-consuming analysis during cross-net optimization. Relatively few vias are produced.
- **Off-Grid Routing Cost Factor** — is considered only when you activate the half-grid option. (See “Via Grid” on page 6-2.) A high off-grid routing cost factor limits the use router’s use of the sub-grid, while a low factor permits frequent use of the sub-grid.

3. Click **OK** to close the Router Cost Factors screen.

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