

# Electronics Workbench™

## Ultriroute 9 Autorouting

*User Guide*

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# Preface

Congratulations on choosing Ultiroute 9 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.

## Documentation Conventions

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



This user guide applies to all versions of Ultiroute. Functions that are available only in some versions are clearly marked with an icon in the left margin.

## Online Help

Ultiroute offers a full helpfile system to support your use of the product.

## Adobe PDF Files

This manual is provided on the Documentation CD as an Adobe PDF file.

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# Chapter 1

## Introduction

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### 1.1 What is Ultiroute?

Ultiroute is an autorouting and autoplacement tool that offers advanced autoplacement with state-of-the-art autorouting for optimal layout of your printed circuit boards. Once installed, Ultiroute is fully integrated with Ultiboard and is accessed from within Ultiboard.

### 1.2 Installing Ultiroute

You must install Ultiboard before installing Ultiroute. If you attempt to install Ultiroute before installing Ultiboard, Ultiroute will not install.

The Ultiroute 9 CD you received will autostart when inserted in the CD-ROM drive. Follow the instructions below and on the screen during the installation process.

- To install Ultiroute 9:
  1. Copy down the Serial Number you received with your Ultiroute 9 package.
  2. Exit all Windows applications prior to continuing with the installation.
  3. Insert the Ultiroute 9 CD into your CD-ROM drive. When the splashscreen appears, click on Ultiroute 9 to begin the installation.
  4. Follow the on-screen prompts to complete the installation.

## 1.2.1 Entering the Release Code

Ultiroute 9 requires you to enter a Release Code within five days of the date of installation. After the five day grace period has expired, Ultiroute 9 will not run until a Release Code is entered.

To obtain your Release Code, you must provide us with your Ultiroute Serial Number and Signature number, as displayed on the splash screen. Contact Electronics Workbench via our website (preferred method) at [www.electronicsworkbench.com](http://www.electronicsworkbench.com) and select the Product Registration link, or call Customer Service at 1.800.263.5552. Customers outside North America should contact their local distributor.

Electronics Workbench recommends that you obtain your Release Code as soon as possible after you have installed Ultiroute 9.

**Note** The Release Code that you will be provided with is composed of 60-alphanumeric characters. Electronics Workbench recommends that you use one of the methods below to enter the Release Code.

➤ To enter the Release Code:

1. Launch Ultiboard. The Ultiroute 9 release code splash screen displays.

**Note** If you launch Ultiboard without having an Ultiroute release code, you may press **Cancel** to continue. Remember that after five days, Ultiroute will not run until a valid release code is entered.

2. If you received your Release Code via email there are a few ways to easily enter it without the need to type each number or character one at a time. Select one of the following methods:

- Highlight the Release Code. Drag and drop it on one of the text boxes.
- Highlight the Release Code, right-click on it and select Copy. Click on the **Paste Release Code** button.
- Highlight the Release Code, right-click on it and select Copy. Right-click on one of the text boxes and click on Paste from the pop-up menu.

3. If you have received your Release Code over the phone, you must type it in the Release Code fields 5 characters at a time.

4. Click **OK** to continue.

# Chapter 2

## Ultiroute User Interface

Ultiroute’s autoplace and autorouting functions are accessed through the **Autoroute** menu in Ultiboard. Once you have installed Ultiroute, the menu items that are specific to these functions are added to the **Autoroute** menu.

Some Ultiroute functions appear in other menus and are also described below.

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## 2.1 Ultiroute Menus and Commands

The majority of commands associated with Ultiroute are accessed from the **Autoroute** menu found in Ultiboard.

These commands are detailed below.

### 2.1.1 Autoroute Menu Items

#### **Autoroute/Start/Resume Ultiroute**



Use to start or resume the built-in Ultiroute autorouter. For details, see “4.4 Running the Autorouter” on page 4-4.

#### **Autoroute/Stop/Pause Ultiroute**



Use to stop or pause the built-in Ultiroute autorouter.

### **Autoroute/Start Ultiroute Autoplace**



Use to autoplace components on your PCB. For details, see “3.3 Running the Autoplacer” on page 3-2.

### **Autoroute/Autoplace Selected Parts**



Use to place part(s) that you have selected on the workspace.

### **Autoroute/Ultiroute Selected Nets**



Use to route net(s) that you have selected on the workspace.

**Note** This is only active when an unconnected pad corresponding to that net is selected.

### **Autoroute/Ultiroute Selected Parts**



Use for routing of all nets for the selected parts. For details, see “3.1 Pre-Placing Parts” on page 3-1.

### **Autoroute/Ultiroute Selected Buses**



Use to autoroute selected buses. For details, see “4.5 Autorouting buses” on page 4-5.

### **Autoroute/Ultiroute Optimization**



Use to optimize the placement of traces. For details, see “4.2.4 Optimization” on page 4-3.

### **Autoroute/Ultiroute Options**



Use to set up router and placer functions. For details, see “5.1 Controlling the Routing Functions” on page 5-1 and “3.4 Controlling the Autoplacer” on page 3-2.

## **2.1.2 Other Menu Items**

The following menu items are added to Ultiboard when Ultiroute is installed.

### **Place/Automatic Test Points**

For details, see “4.6 Placing Automatic Test Points” on page 4-6.

### **Design/Shield nets**

Use to shields nets. For details, see “4.7 Shielding Nets” on page 4-7.

# Chapter 3

## Autoplacement of Parts



This chapter explains how to use Ultiroute's autoplacer to place parts.

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### 3.1 Pre-Placing Parts

You may wish to pre-place certain parts (e.g., holes) before autoplacing other parts.

You should lock the pre-placed parts in place so that they will not be moved.

- To lock part(s) so they will not be moved by the autoplacer:
  1. Select the part(s) that you just placed and choose **Edit/Lock**.
  2. You can also lock parts in place from the **Parts** tab of the **Spreadsheet View**. For details, refer to the *Ultiboard 9 User Guide*.

## 3.2 Understanding How the Autoplacer Works

Ultroute's autoplacer automatically places all unplaced parts onto your board according to the group settings you can specify. It uses a rip-up and retry algorithm to 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. It 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 in the **Results** tab of the **Spreadsheet View** in Ultriboard.

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, 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, Ultroute places block capacitors close to their corresponding ICs.

## 3.3 Running the Autoplacer

- To run the autoplacer, select **Autoroute/Start Ultroute Autoplace**.
- To place only selected parts, selected **Autoroute/Autoplace Selected Parts**.
- To view the results of any autoplacement, select the **Results** tab of the **Spreadsheet View**.  
For details on autoplacer parameters, see "3.4 Controlling the Autoplacer" on page 3-2.

## 3.4 Controlling the Autoplacer

The autoplacer is controlled from the **Autoplace** tab of the **Routing Options** dialog box.

- To enter autoplacer settings:
  1. Select **Autoroute/Ultroute Options**.
  2. Click on the **Autoplace** tab of the **Routing Options** dialog box.

3. In the **Retries** area:
  - **Number of Retries** — enter a number from 1 to 10. This number represents the portion of components that will be placed in each pass. For example, if set to “3”, the placer attempts to place one third of the components, then the next third, etc.
4. In the **Cost Factors** area:
  - **Part Pin Factor** — 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 already been 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. Enter a number from 0 to 10. Entering 0 prioritizes components with the highest absolute number of pin connections. Entering 10 prioritizes components with the highest ratio of connections to total pins. A high part pin factor value usually results in a better distribution of nets than a low 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.
  - **Segment Fit** — used 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. Enter a number from 0 to 10. If you enter 0, there is no segment fit preference, so the autoplacer will not place parts with similar lengths beside each other. Entering 10 indicates a strong preference for aligning parts with equal edge lengths, so the autoplacer will place parts with similar lengths beside each other whenever possible.
5. In the **Parts** area:
  - **Part Rotation Mode** — determines how much the autoplacer is able to rotate through-hole technology 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. Select one of: **None**, for no rotation; **90 Deg**, for 90 clockwise rotation of all autoplaced components; **0 or 90 Deg**, to have components either not rotate, or rotate 90 clockwise; **90 Deg Steps**, to have components rotate either 90, 180, or 270 degrees clockwise.
  - **SMD Mirroring** — lets you place surface mounted devices (SMDs) on both the top and bottom sides of a board and relax the part spacing. You can place SMDs on both the “parts” and the “solder” sides of your boards using mirroring mode. Select **Yes** to allow mirroring of all SMD components or **2-Pin Parts Only** to allow only SMD components with two pins to be placed on the solder side of the board.

- **SMD Rotation Mode** — used to set amount by which surface-mount parts can be rotated during autoplacement. Select one of **None**, for no rotation; **90 Deg**, for 90 clockwise rotation of all autoplaced SMD components; **0 or 90 Deg**, to have components either not rotate, or rotate 90 clockwise; **90 Deg Steps**, to have components rotate either 90, 180, or 270 degrees clockwise.
  - **Global Part Spacing** — enter the minimum allowed space between components.
6. In the **Miscellaneous** area:
    - **Use Pin/Gate Swap** — check to enable pin/gate swapping during autoplacement of parts. Exchanges the nets of gates and/or pins and pin groups, where gates or groups can also be swapped between different parts.
    - **Use Part Swap** — check to enable part swapping during autoplacement of parts. Mutually exchanges identical components at their insertion position in order to minimize trace lengths.
  7. Click **OK** to apply settings.
  8. If you wish to return the values to the default settings for Ultiroute, click **Default**.

---

**Caution** The **Default** button sets default values for all tabs in the **Routing Options** dialog box.

---

## 3.5 Strategies to Achieve Better Part Placement

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

- **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 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.
- **Allow SMD mirroring.** Allows 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.

**Note** All of the above are set up in the **Autoplace** tab of the **Routing Options** dialog box. For details, see “3.4 Controlling the Autoplacer” on page 3-2.

- **Use smaller keep-out or keep-in areas.** Often, a PCB with keep-in areas can be designed with an equivalent set of keep-out areas, or vice-versa. Whenever possible, choose a design strategy that minimizes the total area of the board covered by these keep-in or keep-out areas since each area radically decreases the autoplacement algorithms’ effectiveness.

- **With very dense boards, the last few parts may need to be hand-placed.** The autoplacement algorithms have been carefully tuned to optimize the routability of the final layout, rather than trying to pack all the parts into the smallest possible area. If the autoplacer places all but one or two parts, it may be faster to simply place them on the board by hand—using Ultiboard’s part shoving facility (not available in all versions) to ensure that parts do not overlap—than to spend time trying to tune the autoplacement parameters to achieve complete placement.

# Chapter 4

## Autorouting

This chapter describes the autorouting functions in Ultiroute.

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## 4.1 Understanding How the Autorouter Works

Ultiroute contains four fundamental trace-routing functions:

- router preprocessing
- initial routing
- rip-up and retry passes
- optimization.



Ultiroute uses combinations of these functions to route a board. They are described in “4.2 Understanding the Four Fundamental Routing Functions” on page 4-2. Information on how to use these functions can be found in “4.4 Running the Autorouter” on page 4-4.

## 4.2 Understanding the Four Fundamental Routing Functions

The following sections describe the four fundamental routing functions used by Ultiroute.

### 4.2.1 Router Preprocessing

Before routing begins, Ultiroute analyzes the entire board, considering trace widths, clearances, keepin/out areas, etc. The preprocessor then adapts the router parameters and algorithms best suited for this particular board, for example, routing grid size, pin clearance algorithms, connection routing order.

**Note** Ultiroute uses its own internal routing grid, which is not related to Ultiboard’s grid.

### 4.2.2 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. It also uses copper sharing where appropriate, for example, in a T-junction.

### 4.2.3 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.

Part of Ultiroute's rip-up and retry procedure is to analyze dense board areas and adopt routing strategies in these areas, which decrease 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 achieve poorer routing results than you expect. When changing cost factors, even slight adjustments can have large effects on routing success, either improving or worsening the results.

## 4.2.4 Optimization



The optimizer is usually applied after the autorouter achieves 100% completion. It eliminates unnecessary vias and smooths wire bends to reduce manufacturing costs. It also routes any remaining open connections. You can prevent Ultiroute from calling the optimizer by unchecking **Optimization Pass** on the **General** tab.

The optimizer can also be run separately by selecting **Autoroute/Ultiroute Optimization**. This will also optimize user-placed traces and vias, provided that **Trace can be Moved** is selected in the **General** tab of the trace's properties dialog (for vias, **Via can be Moved** must be selected in the **Via** tab).

## 4.3 Routing Selected Parts and Nets

- To place traces on a selection of parts:



1. Select the desired components and select **Autoroute/Ultiroute Selected Parts**.

- To route selected nets:



1. Select the desired nets and select **Autoroute/Ultiroute Selected Nets**.

**Note** You can also pre-place traces and vias before running the autorouter by using the placement methods described in the *Ultiboard 9 User Guide*.

Once a trace is placed, lock it by selecting **Trace is Fixed** in its properties dialog in Ultiboard. Lock vias with **Via is Fixed**.

Any traces set this way are treated as locked when you run the autorouter.

The autorouter can also be stopped during placement to allow you to place some fixed traces, and then be restarted.

## 4.4 Running the Autorouter

The full autorouter runs an end-to-end autorouting process that includes all four routing functions, applied in the following order:

1. Preprocessing.
2. Initial routing.
3. Rip-up and retry passes.
4. Optimization.



- To perform a full autoroute, choose **Autoroute/Start/Resume Ultiroute**.

Ultiroute begins routing your board and displays its progress in the status line. When the process is complete, the display returns to Ultiboard. The results are displayed in the **Results** tab of the **Spreadsheet View**.

### 4.4.1 Interactivity

Ultiroute provides complete interactivity, letting you stop the routing process as desired to manually place items and then continue autorouting when ready.

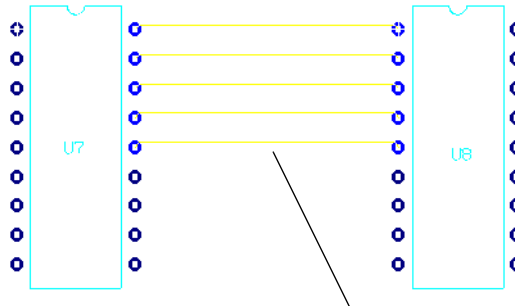
- To stop autorouting, select **Autoroute/Stop/Pause Ultiroute**.
- To restart, select **Autoroute/Start/Resume Ultiroute Autoplace**.

## 4.5 Autorouting buses



You can autoroute buses in Ultiroute.

The following circuit is used in this example.

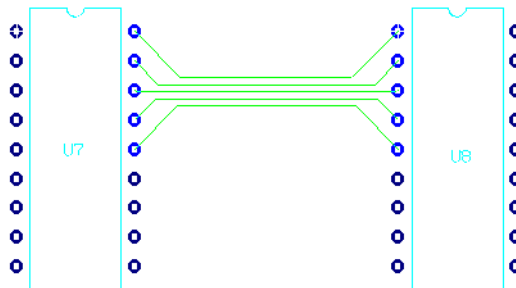


Bus 1 consists of these five nets.

**Note** To autoroute buses, the topology for the nets, as set in the **Net edit** dialog box, must be set to either **Daisy chain** or **Star** and the nets must be part of a Bus Group (on the **Groups** tab of the **Netlist Editor**). For details, refer to the *Ultiboard 9 User Guide*.

➤ To autoroute selected bus(es):

1. Select **Autoroute/Ultiroute Selected Buses**. The **Ultiroute bus routing** dialog box displays.
2. Select the desired buses to route in the **Defined buses** area and click **OK**. The buses are routed as in the following example.



## 4.6 Placing Automatic Test Points

You can automatically place a test point on each net on your design.

- To automatically place test points:

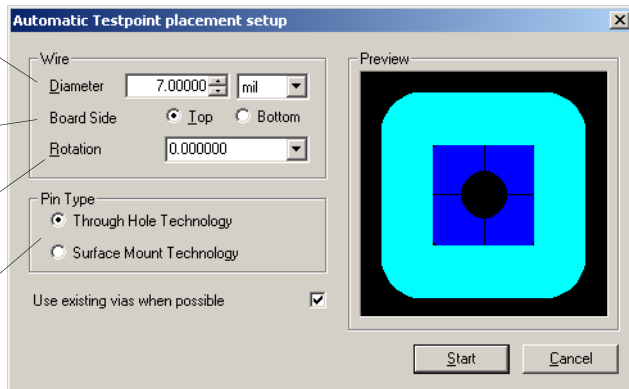
1. Select **Place/Automatic Test Points**.

Set the wire's diameter.  
The Preview area changes accordingly.

Indicate on which side of the board the test points appear.

Set the rotation for the test point. The Preview area changes accordingly.

Choose the type of technology for the test point. The Preview area changes accordingly.



2. Enter the parameters as desired and click **Start**.

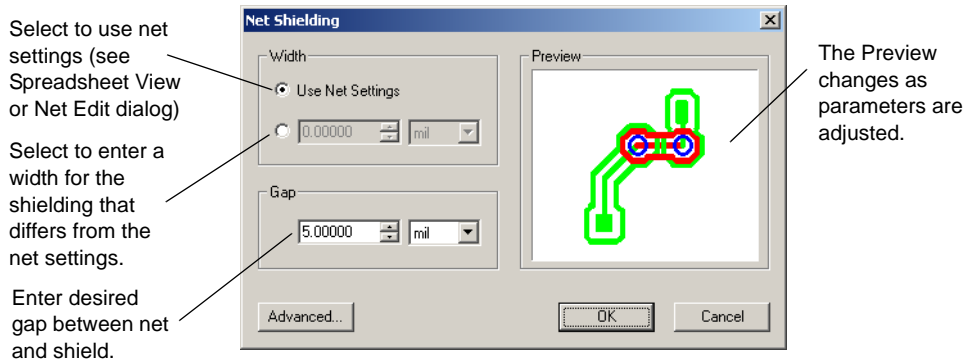
3. The **Automatic Testpoint Placement Setup** dialog box disappears and one test point is placed on or near each net on your board. If placed near an existing net, the test point will be automatically connected.

4. Results of testpoint placements, including a list of any nets which the router could not connect, will appear in the **Results** tab of the **Spreadsheet View**. You can click on an error to go to the unrouted testpoint.

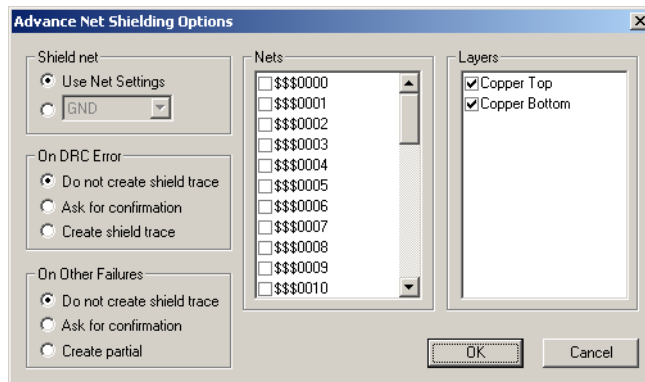
**Note** Testpoints may be placed either before or after autorouting the entire board.

## 4.7 Shielding Nets

- To shield a net:
  1. Select **Design/Shield Nets**. The **Net Shielding** dialog box appears.
  2. Enter the desired settings.



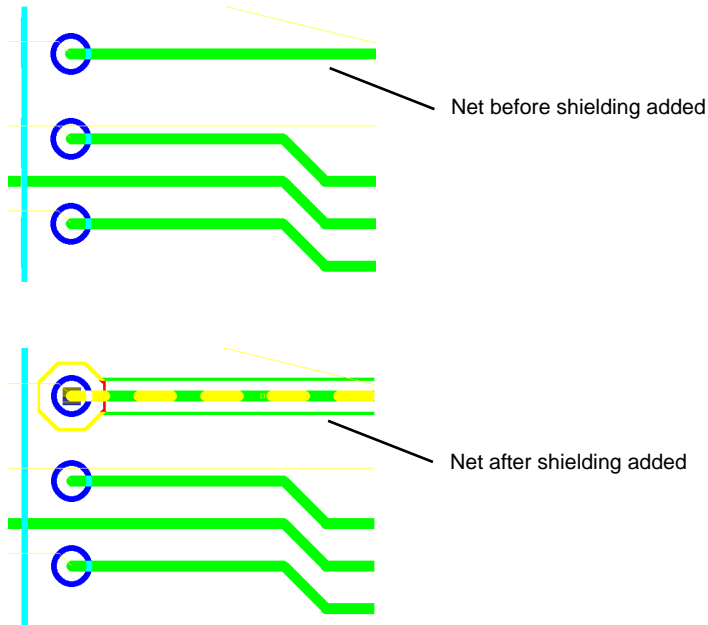
3. Click **Advanced** to display the **Advanced Net Shielding Options** dialog box.



4. Select the net to use for the shield in the **Shield net** area:
  - Use Net Settings** — select to use the shield set in the **Spreadsheet View** (also set in the **Net edit** dialog box).
  - “GND”** — select to activate the drop-down list, where you can pick the net to use for the shield.
5. In the **On DRC Error** area, select the action to take when a DRC error occurs.

6. In the **On Other Failures** area, select the action to take on other errors.
7. In the **Nets** area, select the nets you wish to shield.
8. In the **Layers** area, select the layers on which you wish to place the shielding.
9. Click **OK**. You are returned to the **Net Shielding** dialog box.
10. Click **OK**.

The shielding appears as illustrated below.



11. Results appear in the **Results** tab of the **Spreadsheet View**. You may click on an error to go to the problem area.

# Chapter 5

## Controlling the Autorouter

This chapter describes how to set up the autorouter features in Ultiroute.

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## 5.1 Controlling the Routing Functions

Router functions are controlled through the **Routing Options** dialog box, which is displayed when you choose **Autoroute/Ultiroute Options**.

### 5.1.1 Routing Options: General Tab

- To set up general routing options:
  1. Select the **General** tab in the **Routing Options** dialog box.
  2. Complete the following fields in the **Routing** area:
    - **Routing Mode** — select **Gridbased**, to place the traces on a grid; **Gridless** to place them off the grid; or **Progressive** which will attempt to place the traces on a grid, and then place those that remain off the grid.



- **Grid Type** — select **English** - the router grid will be some sensible number of mils (10 mils, 20 mils, etc.); or **Metric** - the router grid will be some sensible number of millimeters (0.2 mm, 0.3 mm, etc.); or **Board Settings** - Ultiroute will choose either English or Metric, depending on the units Ultiboard is using. This setting is independent of the **Routing Mode** setting in the **Routing** area.
  - **Optimization Pass** checkbox — enable to permit router passes that will optimize the placement of the traces.
3. Complete the following fields in the **Settings** area:
- **Via Grid** — select **100 mil standard**, which places the vias on a 100 mil grid; **50 mil standard**, which places the vias on a 50 mil grid; **25 mil standard**, which places the vias on a 25 mil grid; or **None**, which will not place the vias on any grid. The optimal grid size is determined on-the-fly by Ultiroute during the routing process; if it differs from the **Via Grid** setting, vias will be placed at the grid point closest to the 100, 50 or 25 mil setting.
  - **Pin Contact Mode** — select **Allow Pin Corners** to allow traces to connect to pins diagonally.
  - **Place Vias Under SMD Pads** — select **Yes** or **No** as desired.
  - **Auto Adjust Trace Width** checkbox — enable to allow the router to narrow the trace to its minimum width (if you have Ultiboard PowerPro) as set in the **Nets** tab of the **Spreadsheet View** or the **Width** tab of the **Net edit** dialog box. If you have the Pro edition of Ultiboard installed, the trace is narrowed to one-half of the **Trace Width**.
  - **Fanout BGA Components** — attaches vias to each pin of all BGA (Ball Grid Array) components. If the **DRC** checkbox is enabled, a design rules check is performed before fanouts are placed. In cases where attaching a via to a specific pin would violate a design rule, the via is not attached. This does not affect the attachment of vias to pins where there is no design rule violation. For information on design rules, refer to the *Ultiboard 9 User Guide*.
  - **Use Pin/Gate Swap** checkbox — enable to allow pin/gate swapping while routing to swap equivalent pins/gates to result in more optimal trace connections.
4. In the **Screen Refresh During Routing** area, adjust the slider as desired to set the relative number of times the screen is refreshed during routing.
5. If you wish to return the values to the default settings for Ultiroute, click **Default**.



---

**Caution** The **Default** button sets default values for all tabs in the **Routing Options** dialog box.

---

## 5.1.2 Routing Options: Cost Factors Tab

You may adjust cost factor settings to control how the router “costs” 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 set up cost factor parameters:
  1. Select the **Cost Factors** tab in the **Routing Options** dialog box.
  2. Edit one or more of the following fields in the **Routing and Optimization** area:
    - **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 per Trace** function.
    - **Maximum Via Count per Trace** — this is the maximum number of vias that the router can place between two connected pins.
    - **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 deviations from the preferred direction.
    - **Off-Grid Routing Cost Factor** — is considered only when you activate the half-grid option. 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.
    - **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.
    - **Adjusted Width Cost Factor** — when **Auto Adjust Width** is selected in the **General** tab, a high adjusted width cost factor limits the router’s use of narrow trace widths.

3. Edit one or more of the following fields in the **Routing** area:
  - **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.
  - **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.
  - **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.
4. Edit one or both of the following fields in the **Optimization** area:
  - **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.
  - **Equi-Space Trace Cost Factor** — a high value here indicates that traces will be spread out more during optimization, with a resultingly higher cost.
5. If you wish to return the values to the default settings for Ultroute, click **Default**.

---

**Caution** The **Default** button sets default values for all tabs in the **Routing Options** dialog box.

---

### 5.1.3 Routing Options: Rip-Up Tab

- To set up rip-up parameters:
1. Select the **Rip-Up** tab in the **Routing Options** dialog box.
  2. Edit one or more of the fields in the **Rip-up Trees** area:
    - **Maximum Rip-Up Trees** — sets the maximum number of traces that can be ripped up during each rip-up cycle.
    - **Maximum Rip-Up Depth** — controls the persistence of the rip-up process. The higher the value you set, the greater the persistence each rip-up cycle has (i.e., the more ways the placement is analyzed before a final placement is made).
    - **Maximum Rip-Up Retries** — 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.
- Note** 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.

- **Distance-1 (0 or 1 Grid) Cost Factor** — controls the use of channels left by ripped-up traces in the near distance (0-1 grid point, trace-to-trace). A high value 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 (2 Grid) Cost Factor** — controls the use of channels left by ripped-up traces in the far distance (2 or more grid points, trace-to-trace). A high value results in infrequent use of these channels, forcing relatively more global changes during rip-up and retry routing.
3. Optionally, enable the **Memory Cleanup During Routing** checkbox in the **Router Housekeeping** area to purge the memory of unneeded information.
  4. If you wish to return the values to the default settings for Ultriroute, click **Default**.

---

**Caution** The **Default** button sets default values for all tabs in the **Routing Options** dialog box.

---

## 5.1.4 Routing Options: Optimization Tab

➤ To set optimizer options:



1. Select the **Optimization** tab in the **Routing Options** dialog box.
2. Edit one or both of the fields in the **Optimizer** area:
  - **Optimizer Passes** — use to set the number of optimizer passes that are automatically activated after the autorouter achieves 100 percent completion.
  - **Optimization Direction** — select **Normal** to instruct the optimizer to ignore layer-specific preferred routing directions to keep the number of vias to a minimum; **Preferred Direction** to instruct the optimizer to consider layer-specific preferred routing directions. This may increase the number of vias on your board; **45 Degrees** to instruct the optimizer to prefer 45 degree routing where appropriate.
3. Optionally, enable the **Memory Cleanup During Optimizing** checkbox in the **Optimizer Housekeeping** area to purge the memory of unneeded information.
4. If you wish to return the values to the default settings for Ultriroute, click **Default**.

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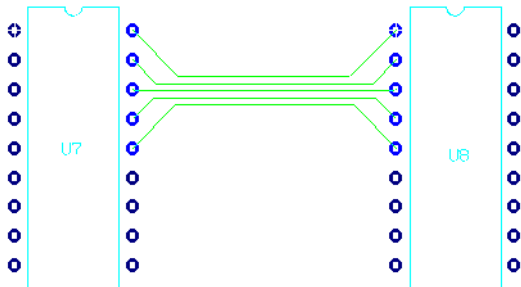
**Caution** The **Default** button sets default values for all tabs in the **Routing Options** dialog box.

---

## 5.1.5 Routing Options: Ultroute Bus Routing Tab

To autoroute buses, the topology for the nets, as set in the **Net edit** dialog box, or the **Spreadsheet View**, must be set to either **Daisy chain** or **Star** and the nets must be part of a Bus Group as set in the **Edit Groups** dialog box in Ultiboard. For details, refer to the *Ultiboard 9 User Guide*. You can also add new Bus Groups from the **Ultroute Bus Routing** tab Ultroute's **Routing Options** dialog box.

- To set Ultroute bus routing options:
  1. Select the **Ultroute bus routing** tab in the **Routing Options** dialog box.
  2. Select the desired buses to route in the **Defined buses** area. Click **Select All** to select all available buses for routing or **Clear All** if you wish to clear all of the checkboxes in the **Defined buses** area.
  3. If you wish to add or delete bus groups, or change a bus group's **Assigned Nets**, click **Edit**. The **Bus Groups** tab of the **Edit Groups** dialog box appears where you can **Add** or **Delete** bus groups. You can also change the nets assigned to a specific bus group from here by selecting or de-selecting the group's checkbox in the **Assign Nets** list.
  4. When you start Ultroute, the buses are routed as in the following example.



5. If you wish to return the values to the default settings for Ultroute, click **Default**.

---

**Caution** The **Default** button sets default values for all tabs in the **Routing Options** dialog box.

---

## 5.2 Strategies to Achieve Better Routing Results

- **Speed and completion may be trade-offs.** Many of the suggestions for routing completion will greatly increase the time needed to complete routing. While it may be tempting to try to guarantee completion by using all possible completion tricks for all layouts, many non-dense boards can be completely routed without them, and they will be routed much faster.
- **Set alternating layer biases.** By default, each new Ultiboard project will have trace biases that alternate between horizontal and vertical with each successive layer. This setting greatly increases routing speed and completion rates and should not normally be changed. The exception is if you have placed several powerplanes. Because the router does not route traces on powerplane layers, these layer biases may need to be adjusted to preserve this alternating pattern so that it skips over those powerplane layers.
- **Try gridless routing.** The default setting for routing is gridbased, which is the fastest routing algorithm. If this fails to achieve completion, then next step should almost always be to try gridless routing.
- **Make sure there is no via grid.** The via grid increases routing speed by limiting the costly via placement calculations, but it can decrease routing completion since vias may not be placed in crowded areas of the board.
- **Try auto adjust trace width.** If your design permits, set a smaller minimum width for some nets and turn on the “Auto Adjust Trace Width” feature.
- **Check your minimum/maximum lengths (Ultiroute Power-Pro only).** Sometimes traces may not be routed because the pins are too far away to be routed with your specified maximum length, or too close together to be routed with your specified minimum length (the router can only increase the length of a trace by about sixty percent over optimum). Similar routing failures may occur with differential pairs when one leg of the pair is much longer than the other. In these cases, you should either change your minimum or maximum length settings, or route these problematic connections with Ultiboard’s follow-me router to achieve the desired length.

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