

6 BPR Tutorial

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Introduction

This tutorial demonstrates some of the key steps in the BPR design flow using a simple example design.

The tutorial uses three files, which you can find in the **samples\bpr\adder1bit** subdirectory of the main L-Edit directory.

The first file—**Adder1bit.tdb**—is used as a source for setup information when you create your own tutorial file.

The second file—**Adder1Bit_placed.tdb**—is used to demonstrate automatic routing.

The third file—**Adder1Bit_routed.tdb**—is used to demonstrate assisted manual routing.

Design Preparation

To perform block placement and routing, all the cells referenced in the netlist must exist in the active layout file.

This section of the tutorial shows you how to:

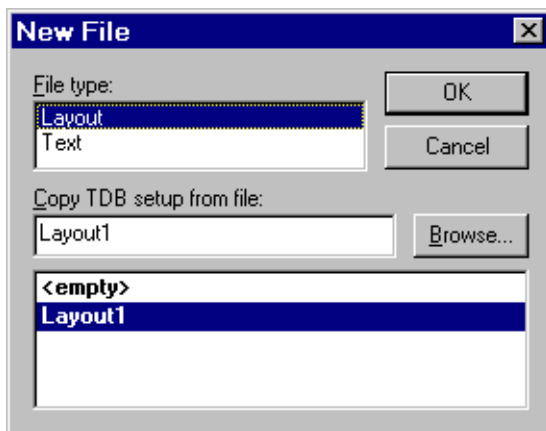
- Launch L-Edit and choose a setup file
- Use the Design Navigator to copy cells into a design

You will copy the cells you need for initialization from **Adder1bit.tdb** to **tutorial.tdb**.

Launching L-Edit and Opening a File

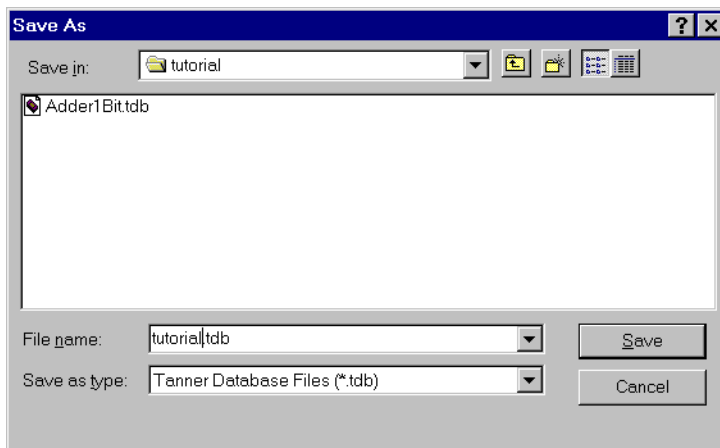
- ☑ Launch L-Edit. L-Edit opens with **Cell0** of a new empty file **Layout1** open.
- ☑ Use **File > New** to open the **New File** dialog. You will use this dialog to import palette, application, design, and layer setup values into the **Layout1** file.

- ☑ Select **Layout** in the **File type** field. Click **Browse** to navigate to the L-Edit **samples\bpr\adder1bit** subdirectory and select the file **Adder1bit.tdb**.



- ☑ Click **OK** to close the **New File** dialog.
- ☑ Close the **Layout1** file. (**Cell0** of **Layout2** should be the only open window.)

- ☒ Use **File > Save** to save your file in the **BPR\Adder1bit** subdirectory as **tutorial.tdb**.



This completes the design preparation section of the tutorial.

Initialization

In order to initialize a design for BPR, all the cells referenced in the netlist must exist in the active layout file. You also need to specify the netlist that L-Edit will read for connectivity information, and several other initialization parameters.

TPR Netlist Initialization

When BPR is initialized with a TPR netlist, the I/O cell can be explicitly included in the netlist file. Or, if an I/O cell is not defined in the schematic, but port names have the same names as the net names defined for the I/O cell in the design, BPR will automatically add connections from the I/O cell ports that match those net names to the nets.


EDIF Netlist Initialization

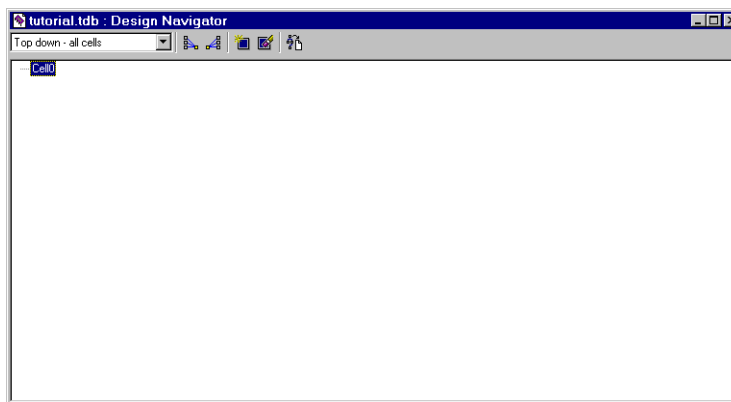
When BPR is initialized with an EDIF netlist, you do not need to define an I/O cell in the schematic if external ports are defined in the netlist for the top-level BPR cell (as is the case with the **Adder1Bit_extPorts.edn** file used in this tutorial). Or, as with TPR format, you can create an I/O cell in the schematic and include it explicitly in the netlist (as is the case with the **Adder_IO** cell in the **Adder1Bit.edn** file also included in the **samples\bpr\adder1bit** subdirectory).

This section of the tutorial shows you how to:

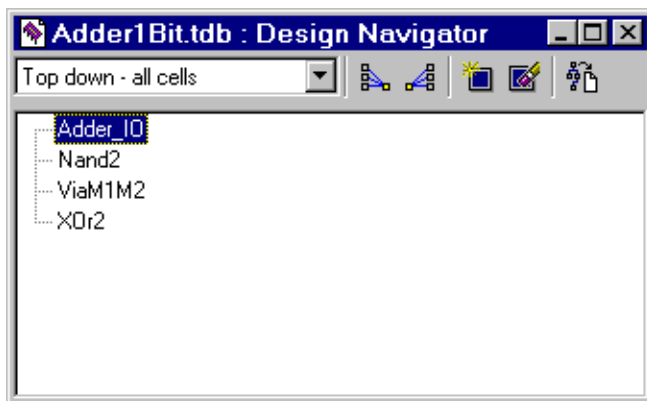
- Copy cells into your design file
- Specify the netlist to read
- Enter initialization values
- Specify a top-level BPR cell
- Specify a top-level I/O cell

Copying Cells Using the Design Navigator

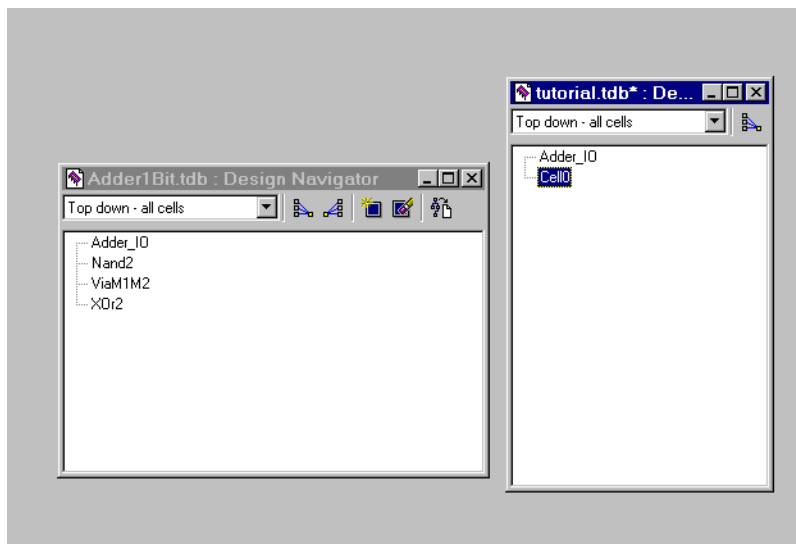
- ☑ With **Cell0** of **tutorial.tdb** active, click on the Design Navigator icon (). L-Edit will display a list of the cells in that file.



- ☒ Open the **Adder1bit.tdb** file and open the Design Navigator if it is not already displayed.

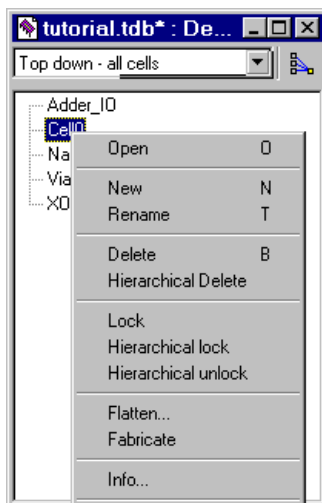


- ☑ Click on the **Adder_IO** cell in the **Adder1bit.tdb Design Navigator** and drag a copy over to the **tutorial.tdb Design Navigator**.



- ☑ Repeat the previous step to copy the cells **Nand2**, **ViaM1M2**, and **XOr2** into **tutorial.tdb**.
- ☑ With the **tutorial.tdb Design Navigator** active, use **Ctrl+S** to save your **tutorial.tdb** file.

- ☑ Right-click on **Cell0** in the **tutorial.tdb Design Navigator**. Click on **Rename** and type the name **top-level**.



- ☑ Close the **Adder1bit.tdb Design Navigator**.
- ☑ Double-click on **top-level** in the **tutorial.tdb Design Navigator** to open it as the active cell.

- ☑ Use **Tools > BPR > Initialization** to open the **BPR Initialization** dialog. You will use this dialog to:
- Enter a netlist
 - Set a default signal type
 - Specify a top-level I/O cell
 - Set the routing pitch
 - Pick a routing guide layer

Completing the BPR Initialization Dialog

- ☑ Complete the **BPR Initialization of cell top-level** fields as shown below.

BPR Initialization of cell top-level

Netlist information

Netlist file: .\\edit\\samples\\bpr\\adder1bit\\adder1bit_extPorts.edn [Browse...](#)

☒ Top level only ☐ Flatten [Cell Mapping Table](#)

Signal type assignment

	Default	Signal Type	Net Name
1	<input type="radio"/>	Clock	
2	<input type="radio"/>	Power	
3	<input type="radio"/>	Ground	
4	<input checked="" type="radio"/>	Signal	

[Add](#) [Delete](#)

Top level I/O

☒ Top level I/O cell: Adder_IO

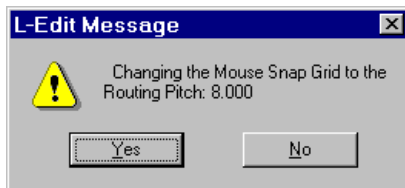
Routing pitch: 8.000 Locator Units

Layers

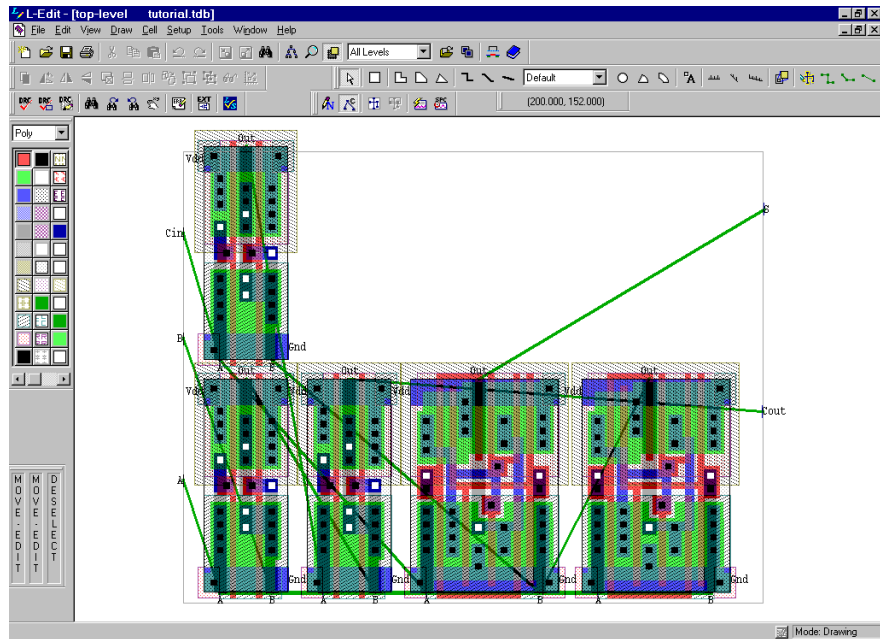
Routing guide layer: Routing Guides

[Initialize](#) [Cancel](#) [Setup...](#)

- ☑ In the **Netlist file** group, browse to the **bpr\Adder1bit** subdirectory and select the **Adder1Bit_extPorts.edn** netlist.
- ☑ Select the netlist option **Top level only**.
- ☑ Select **Signal** as the default **Signal Type**.
- ☑ Select **Adder_IO** from the cells in the **Top level I/O cell** pull-down list.
- ☑ Enter a routing pitch of **8.000**.
- ☑ Select **Routing Guides** from the layers in the **Routing guide layer** pull-down list.
- ☑ Click **Initialize**.
- ☑ Before initialization is complete, L-Edit will prompt you to change your mouse snap grid setting to match the routing grid setting. Click **Yes**.



- ☑ Maximize the window and press the **Home** key.
- ☑ The initialized design should look like this:



- ☑ Save and close the **tutorial.tdb** file. This ends the initialization section of the tutorial.



Automatic Routing

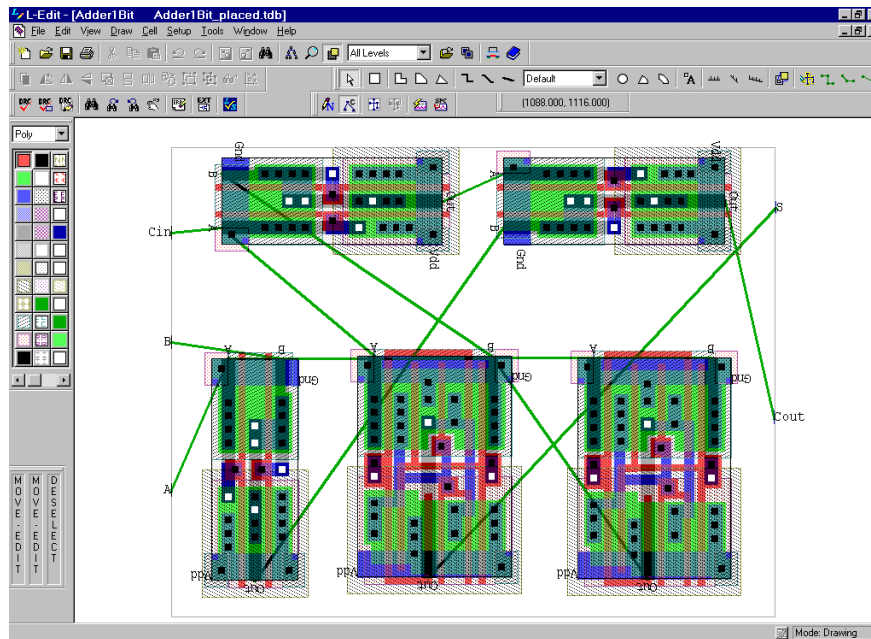
After initialization, you can place the blocks in your design manually or by using the automatic placement feature of BPR. This section of the tutorial demonstrates automatic routing and assisted manual routing using a file that has already been placed (**Adder1Bit_placed.tdb**).

The autorouter can route a set of selected nets or all nets in a design. You can use the assisted manual routing tools for hand-routing specific nets where you want more control.

This section of the tutorial shows you how to:

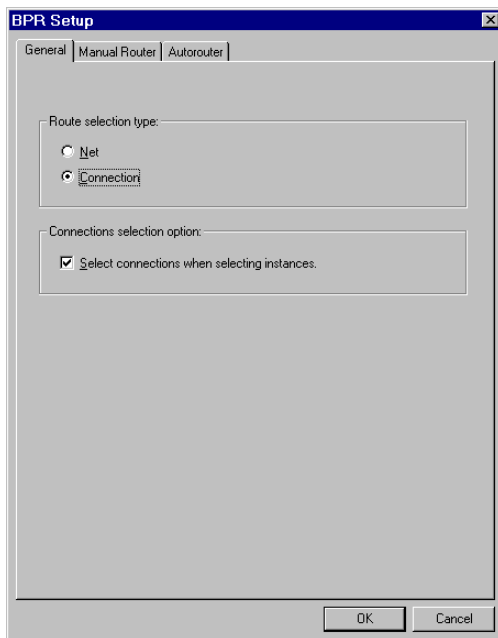
- Define routing layers and via cells, set wire widths, a keep-out and subcircuit recognition layer, routing pitch, and any excluded signals
- Use the automatic router to route an entire design
- Read the **Netlist Navigator** for net information
- Use assisted manual routing to route a net

- ☑ Use **File > Open** to open the **Adder1Bit_placed.tdb** file in the **\samples\bpr\adder1bit** subdirectory. Maximize the window and press the **Home** key so the design fills the window as shown below.



Route Selection Setup

- ☑ Use **Tools > BPR > Setup—General** to confirm that the **Route selection type** is set to **Connection**.



- ☒ Set the **Connection selection option** to **Select connections when selecting instances**.

(Refer to [Selecting Nets, Connections, and Objects on page 2-199](#) for a description of these values.)

Autorouter Setup

- ☑ Click on **Autorouter** to confirm that fields in that tab of **BPR Setup** are set as shown below:

BPR Setup

General | Manual Router | **Autorouter**

Routing layers

Horizontal layer: Metal1 Routing wire width: 4.000 Locator Units ☒ Default

Vertical layer: Metal2 Routing wire width: 4.000 Locator Units ☒ Default

Via cell name: ViaM1M2 Adjacency: Side by side

Routing keep-out layer: Keep-out

Subcircuit recognition layer: SubCkt ID

☒ Rip-up routing violations Routing pitch: 8.000 Locator Units

☒ Create breakouts Breakout grid: 0 Routing grid points

☒ Via minimization Remove vias for segments less than 32.000 Locator Units

Exclude signal types from routing

	Signal Type	Exclude
1	Signal	<input type="checkbox"/>
2	Ground	<input checked="" type="checkbox"/>
3	Power	<input checked="" type="checkbox"/>
4	Clock	<input type="checkbox"/>

OK Cancel

- ☑ Select **Metal1** in the **Horizontal layer** field.
- ☑ Select **Metal2** in the **Vertical layer** field.
- ☑ Check the **Default** box for each **Routing wire width**.
- ☑ Select **ViaM1M2** from the cells in the **Via cell name** drop-down list.
- ☑ Select **Side by side** in the **Adjacency** field.
- ☑ Select **Keep-out** from the layers in the **Routing keep-out layer** drop-down list.
- ☑ Select **SubCktID** from the layers in the **Subcircuit recognition layer** drop-down list.
- ☑ Check **Rip-up routing violations**.
- ☑ Enter a **Routing pitch** of **8.000** locator units.
- ☑ Check **Create breakouts** and enter a **Breakout grid** of **0** routing grid points.
- ☑ Check **Via minimization** and enter **32** in the **Remove vias for segments less than** field.
- ☑ Click **Exclude** for the signal types **Ground** and **Power** in the **Exclude signal types from routing** group.

- ☑ Click **OK** to close the **BPR Setup** dialog.

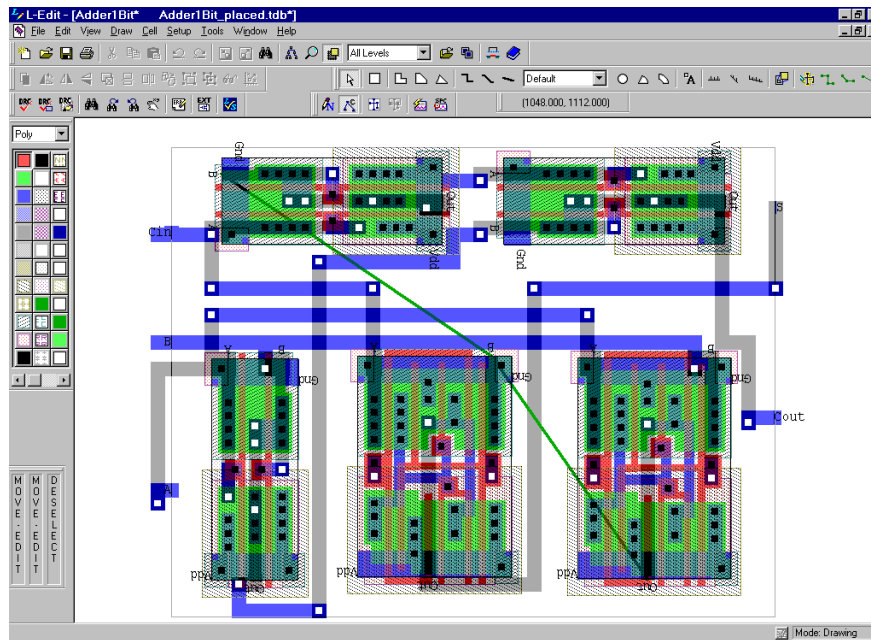
Running the Automatic Router

- ☑ Use **Tools > BPR > Route All** to automatically route all nets in the design.
- ☑ BPR will display the following **Automatic Routing Report** when the router has completed its attempt. Note that seven nets were completely routed, and one net was not routed at all.



- ☑ Click **OK** to close the routing report.
- ☑ Maximize the window and press the **Home** key.

- ☒ The automatically routed design should look like this:



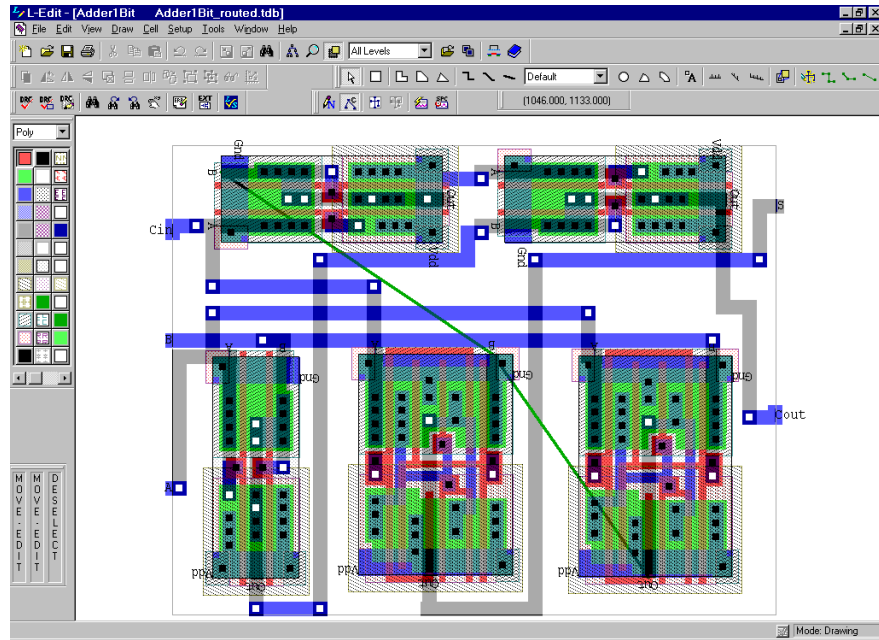
- ☒ Close the **Adder1bit.tdb** file without saving it. This ends the automatic routing section of the tutorial.

Using the Netlist Navigator

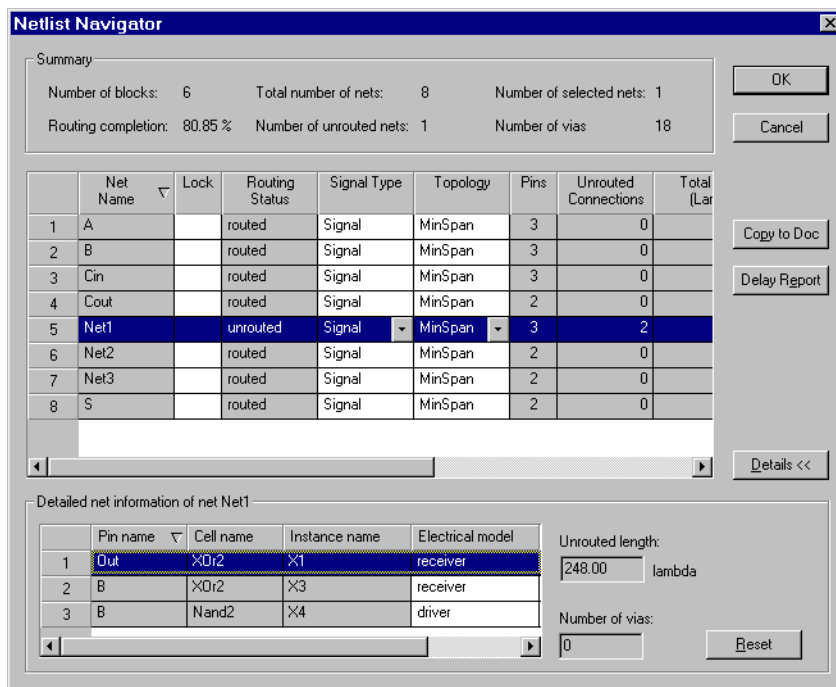
This section of the tutorial shows you how to use the **Netlist Navigator** to:

- Check the length of the unrouted section of a net
 - Select and display a net
- ☒ Open the **Adder1bit_routed.tdb** file.

- ☑ Maximize the window and press the **Home** key so the design fills the window, as shown below:

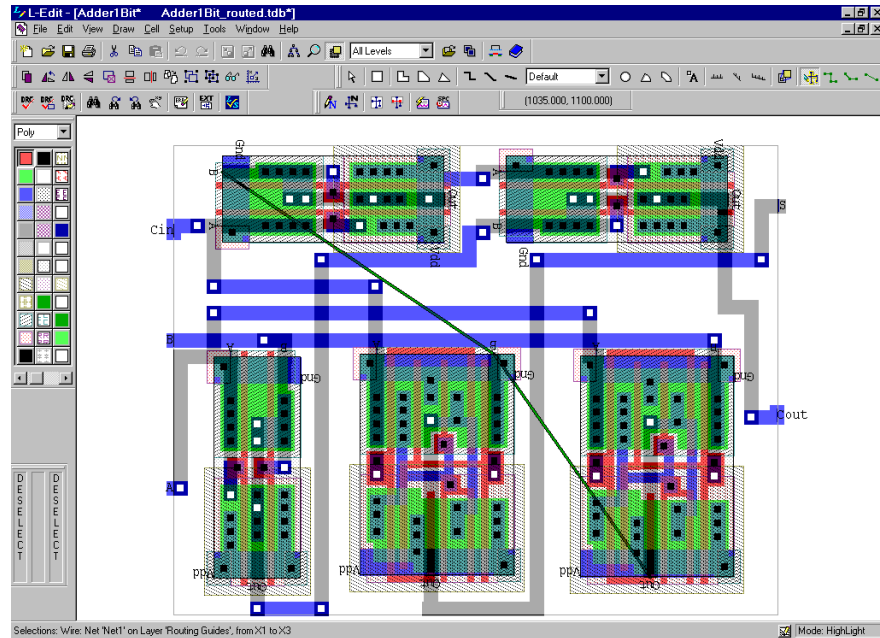


- ☑ With the **Adder1Bit** cell active, use **Tools > BPR > Netlist Navigator** to open the **Netlist Navigator**.





- ☑ Note (in the **Summary** group) that the overall **Routing Completion** for the design is **80.85%**.
- ☑ Click on **Net1** to highlight it.
- ☑ Note that the **Routing Status** for **Net1** is **unrouted**. Its **Unrouted Length** (in the **Detailed net information** group) is **248.00** lambda.

- ☑ Click **OK** to close the **Netlist Navigator** and return to the layout display.



- ☑ In the layout, the routing guide connecting instance **X1** to **X3** should remain highlighted. (In this example the select color for the routing guide layer is green with a black outline.)

Controlling Highlighting

- ☑ Click on the **Highlight Mode** icon () so that what is selected will be highlighted in the layout.
- ☑ Click on the **Select Nets/Connections** icon () to display nets rather than connections. With net selection active, the routing guide connecting instance **X3** to **X4** will be highlighted as well.

(Refer to [Highlighting Selected Nets or Connections on page 2-200](#) for a description of these functions.)

- ☑ The L-Edit status bar will display the type of selection (**Wire**), the name of the net the selection belongs to (**Net1**), the layer on which it is drawn (**Routing Guides**), and the names of the instances it connects (from **X1** to **X3**), as shown below.

Selections: Wire: Net 'Net1' on Layer 'Routing Guides', from X1 to X3

- ☑ You should keep the **Adder1bit_routed.tdb** file open for the next section of the tutorial.

This ends the **Netlist Navigator** section of the tutorial.

Assisted Manual Routing

The assisted manual routing feature provides a constant display of electrical connections as you draw routing, in the form of a routing guide between your cursor and the port. A net will stay selected during all assisted manual routing operations unless you deselect it by clicking elsewhere in the layout.

You can define any number of routing layers and vias to use with this feature. Each time you switch from one routing layer to another, BPR automatically adds the via defined to connect those layers. If you have not defined a via connecting the two routing layers you are trying to route with, L-Edit will display the following error message:



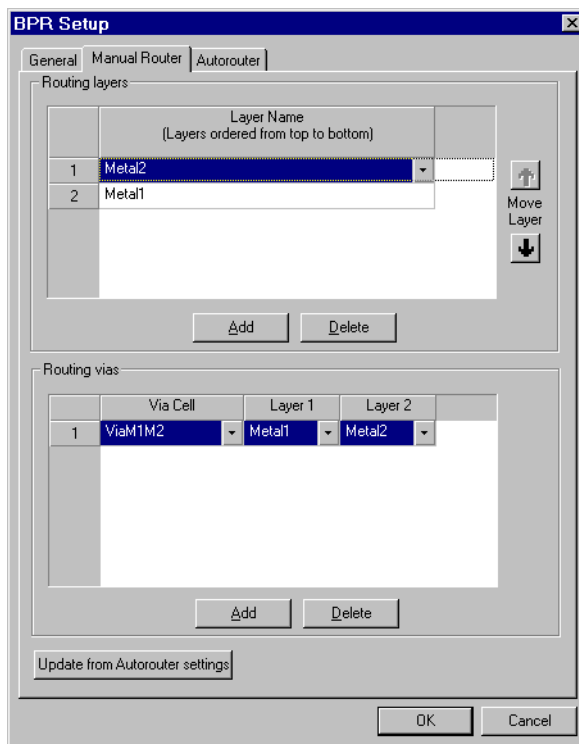
Once your routing layers and vias are defined, select the net you want to route, pick a routing wire tool, and choose the layer you want to route on. If no manual routing layer is selected when you pick a routing wire tool, BPR will automatically make the top routing layer in your manual routing layer list the active layer.

This section of the tutorial shows you how to:

- Add routing layers and a via cell to those defined for use with the assisted manual router
- Turn off the display of selected layers
- Change assisted manual routing layers using shortcut keys
- Use assisted manual routing to route a net

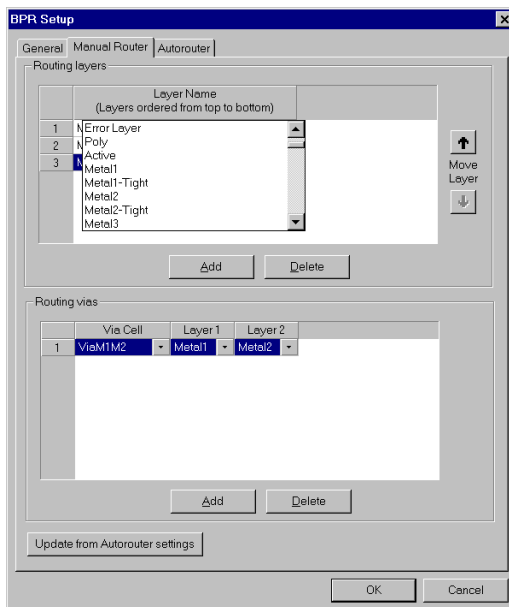



- ☑ Continuing with the **Adder1Bit_routed.tdb** file, use **Tools > BPR > Setup—Manual Router** to confirm that fields in that tab of **BPR Setup** are set as shown:



Adding Assisted Manual Routing Layers

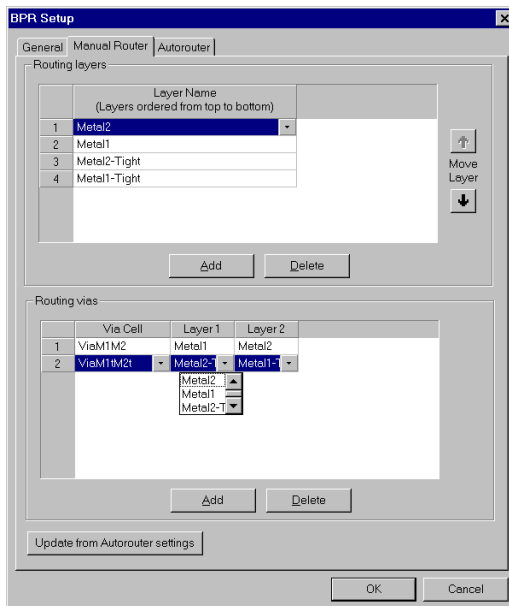
- ✓ Click **Add** in the **Layer Name** list
- ✓ Click on the pull-down menu arrow and select the layer **Metal1-Tight** to add it to the layers defined for use with assisted manual routing.



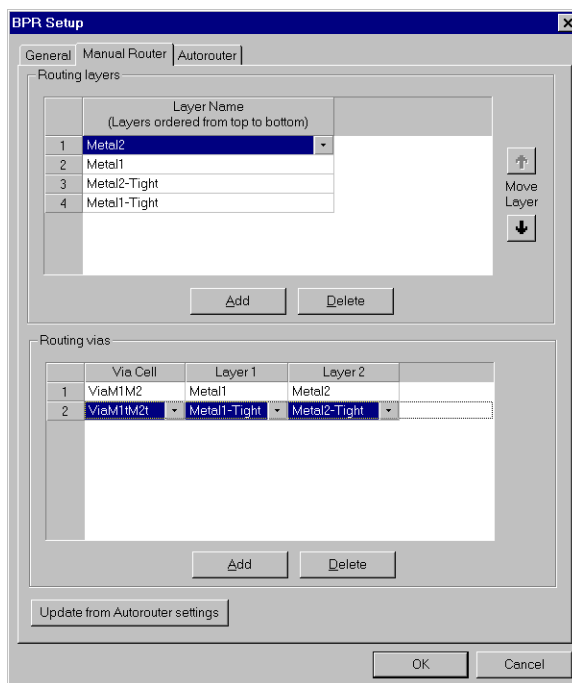
- ☑ Repeat the above steps to add **Metal2-Tight** to the list of assisted manual routing layers.
- ☑ With layer **Metal2-Tight** highlighted, click the **Move Layer** up button (). Move **Metal2-Tight** so it is the third layer in the **Routing Layers** list.

Adding Assisted Manual Routing Vias

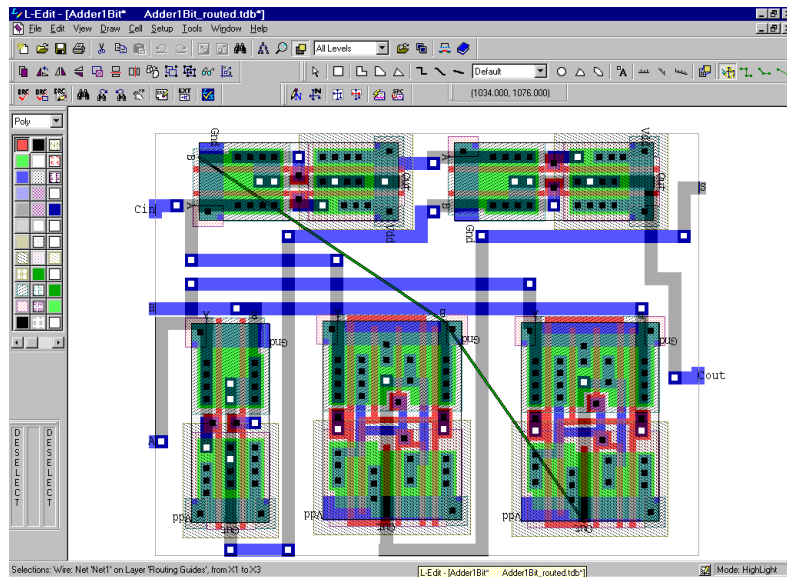
- ☑ Click **Add** in the **Routing Vias** group and select the via cell **ViaM1tM2t** from the pull-down list of cells to add it to the vias defined for use with assisted manual routing.



- ☑ With **ViaM1tM2t** selected in the **Routing vias** table, select **Metal1-Tight** from the **Layer 1** pull-down menu and **Metal2-Tight** from the **Layer 2** pull-down menu to set the layers it will connect.



- ☑ Click **OK** in the **BPR Setup** dialog to return to the layout display.



- ☑ The status bar should show that **Net1** is still selected. If it is not, use the left (SELECT) mouse button to click on either of its connections.

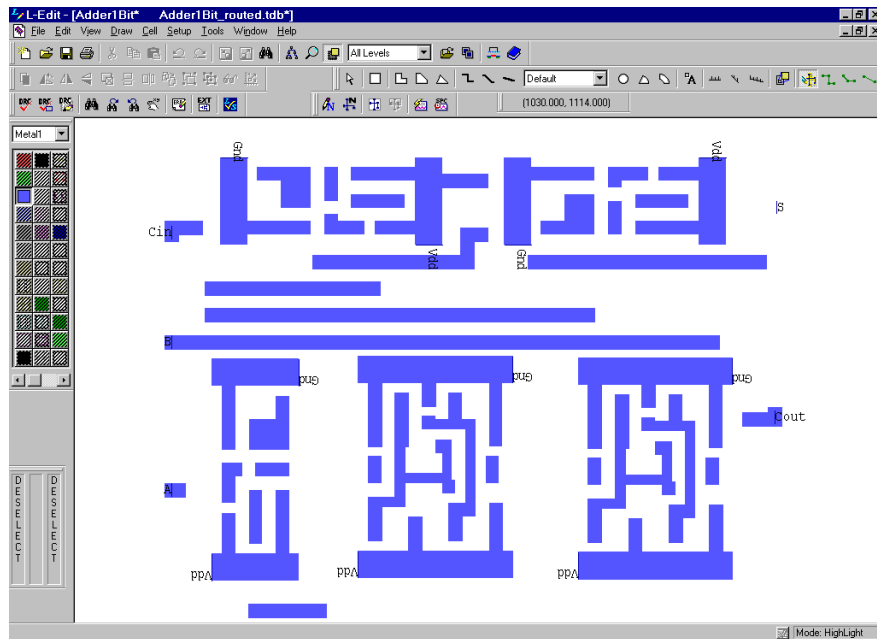
Hiding Unnecessary Layers

To improve visibility during assisted manual routing, you can hide unnecessary layers, leaving only the routing, routing guide, and subcircuit recognition layers visible. The easiest way to do this is to first hide all layers, then show the critical layers.

- ☑ Select layer **Metal1** by placing the pointer over layer **Metal1** in the Layer palette and clicking the left (CHOOSE) mouse button.

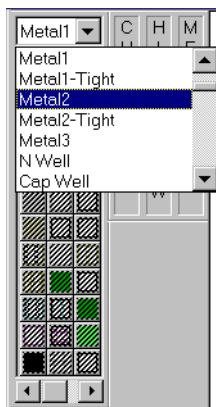


- ☑ Use **View > Layers—Hide All** to hide all layers. (The active layer, in this case **Metal1**, will remain visible.)

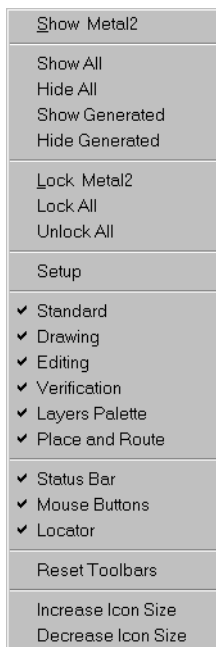


Hiding Using the Layers Palette

- ☑ Move your cursor to the Layer palette, click on the pull-down menu, and select **Metal2**. The **Metal2** button on the Layer palette will be highlighted with a black outline.

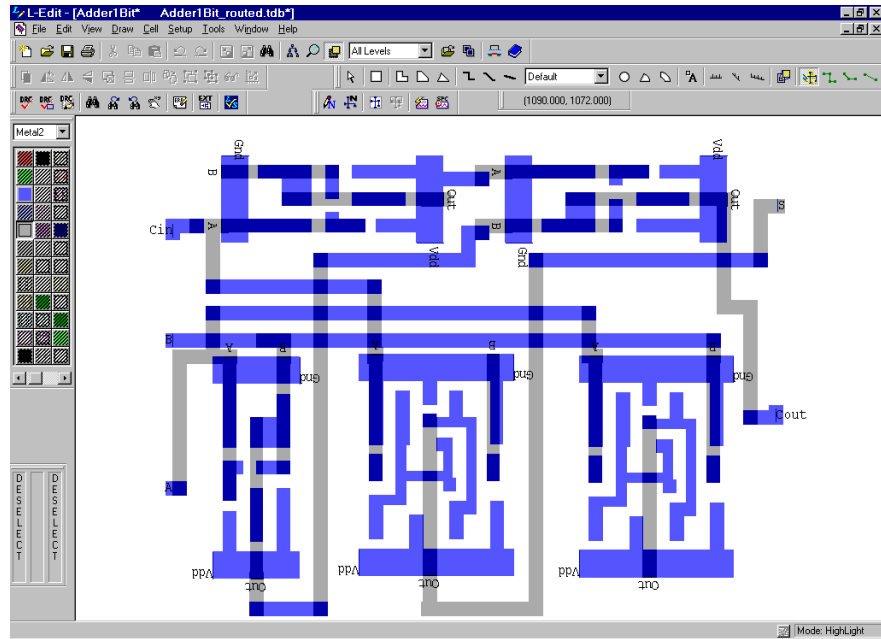


- ☑ Right-click on the **Metal2** button on the Layer palette to open the menu shown below.





Click on **Show Metal2** to turn on the display of layer **Metal2**.

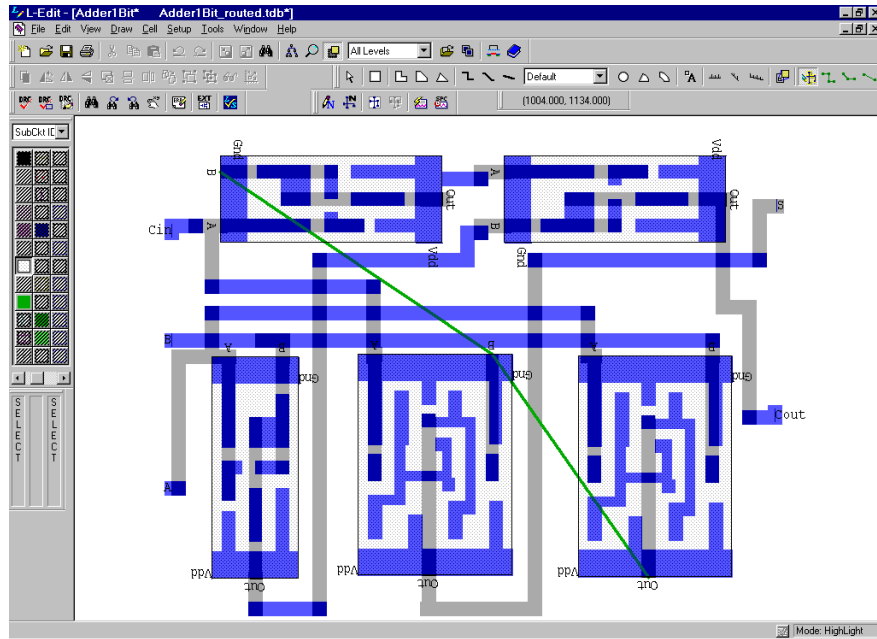


- ☑ You can also use the middle (HIDE/SHOW) mouse button on the Layer palette to toggle layer visibility. Middle-click on the **Routing Guides** button in the Layer palette to turn on display of the routing guide layer.



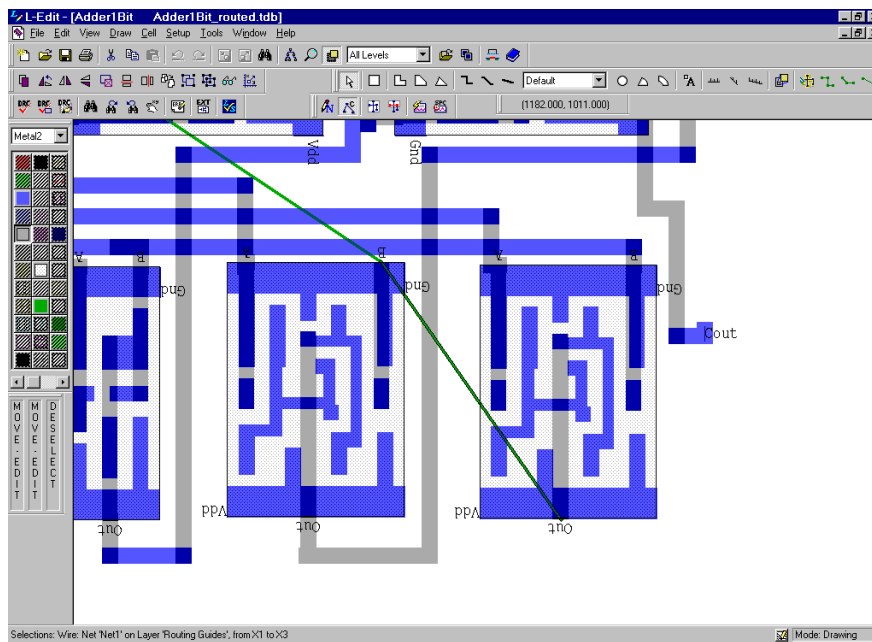
In default view, the **Routing Guides** layer is 9 rows down in the middle column of the Layer palette.

- ☑ Middle-click on **SubCktID** in the Layer palette to toggle display of that layer, as shown below.



Zooming-in to Route


- ✓ Press **Z** and draw a zoom box around the lower right portion of the design to zoom in as shown below.



- ☑ The **Net 1** connection should still be highlighted, as shown in the status bar below. If it is not, simply click on it in the layout.

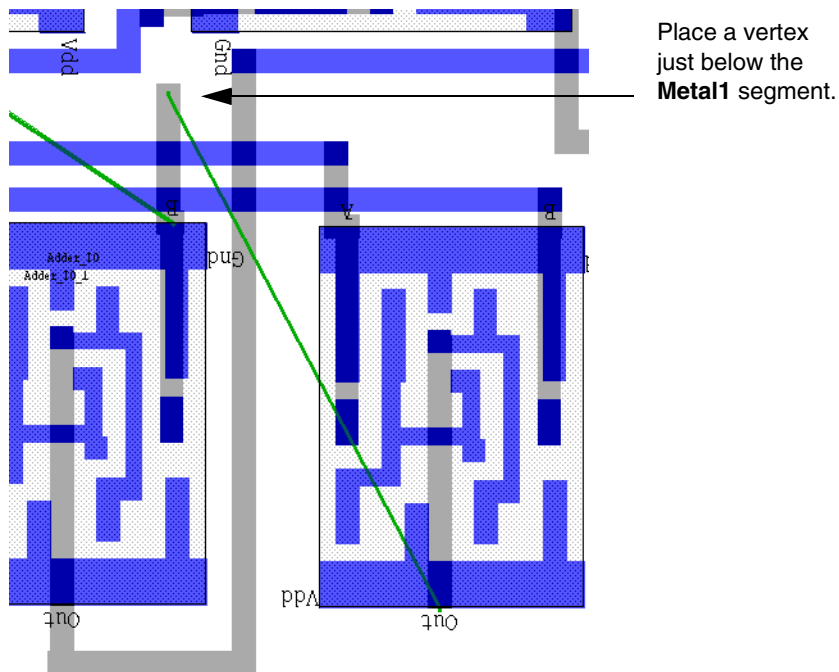
Selections: Wire: Net 'Net1' on Layer 'Routing Guides', from X1 to X3

Selecting a Wire and Layer for Routing

- ☑ Click on the toolbar button **Orthogonal Routing Wire** .
- ☑ Select **Metal2** in the Layer palette.
- ☑ The L-Edit status bar will indicate the active routing layer:

Metal2

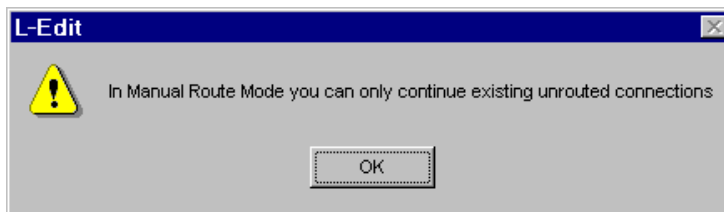
- ☒ Click directly on port **B** and drag North with the left (DRAW) mouse button to draw a vertical **Metal2** segment, as shown below.





- ☑ Click the left (VERTEX) mouse button to add a vertex. The routing guide will remain selected.

If You Lose Selection of the Routing Guide

If at any time you lose selection of the connection you are routing while you are in assisted manual routing mode, BPR will display the following warning:



Take the following steps:

- ☑ Click on the toolbar button **Selection** .
- ☑ Select the routing guide for **Net1** where it meets the most recently drawn routing wire.
- ☑ Once the routing guide is selected, click on the toolbar button **Orthogonal Routing Wire** .

- ☑ Click at the very end of the routing guide exactly where it connects with the routing wire.

Using Keyboard Shortcuts to Select a Routing Layer

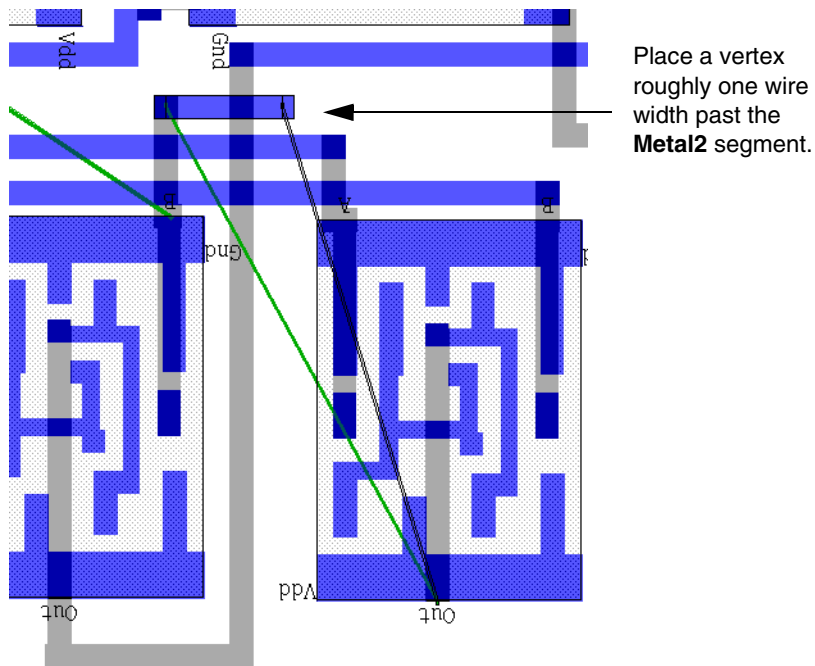
You can use keyboard shortcuts to cycle through the defined assisted manual routing layers, as follows:

Use **Draw > Next Routing Layer (F11)** to cycle down and **Draw > Previous Routing Layer (F12)** to cycle up the list of routing layers as they appear in the **Layer Name** list in the **BPR Setup—Manual Router** dialog. Both functions cycle continuously through the layer list.

Next Routing Layer and **Previous Routing Layer** change the layer of the routing wire you are *currently* drawing. This is true whether you draw wires using a “rubberbanding” mouse operation, where you do not hold the mouse button down as you draw, or a “click and hold” mouse operation—the layer will change for the wire that has not yet been completed.

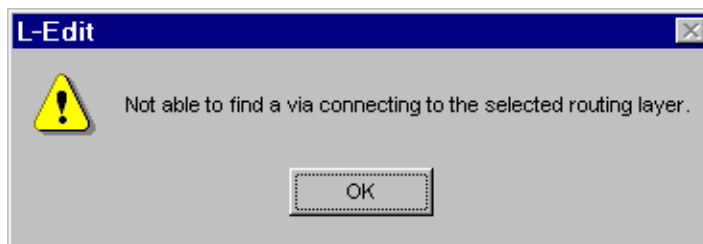
- ☑ Press **F12** to cycle up the routing layer list to **Metal1**.

- ☑ Click and drag to the East with the left (DRAW) mouse button to draw a horizontal segment on **Metal1**, as shown below.



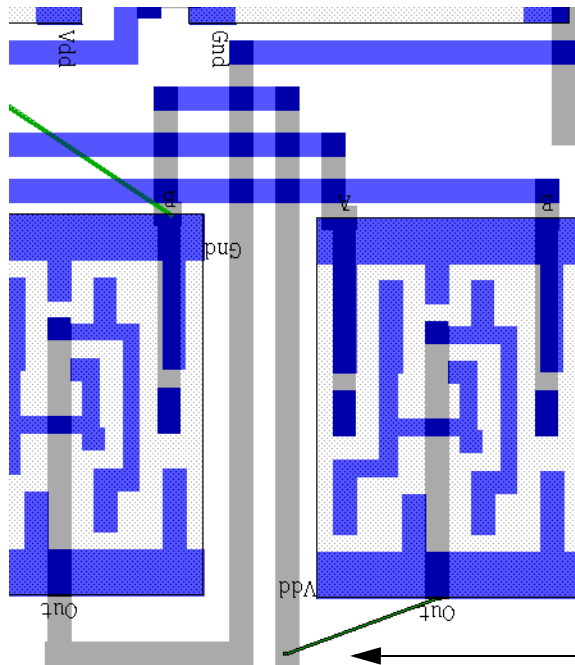
When you switch between assisted manual routing layers, BPR automatically places a via (assuming one is defined for the layer transition) to make a connection. The vias will be visible when all layers are visible.

If no via is defined to connect the two layers you are switching from, BPR will display the following warning:



- ☑ Click the left (VERTEX) mouse button and press **F11** to cycle down the routing layers list to select **Metal2**.

- ☑ Click and drag to the South with the left (DRAW) mouse button to draw the third wire segment vertically on **Metal2**, as shown below.

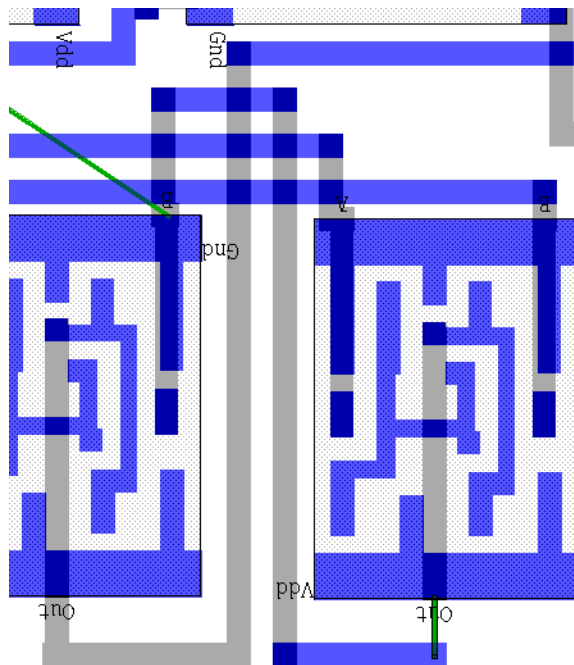


Place a vertex so it is aligned with the end of the adjacent **Metal2** segment.

- ☑ Click the left (VERTEX) mouse button to add a vertex and press **F12** to cycle up the routing layers list to select **Metal1**.

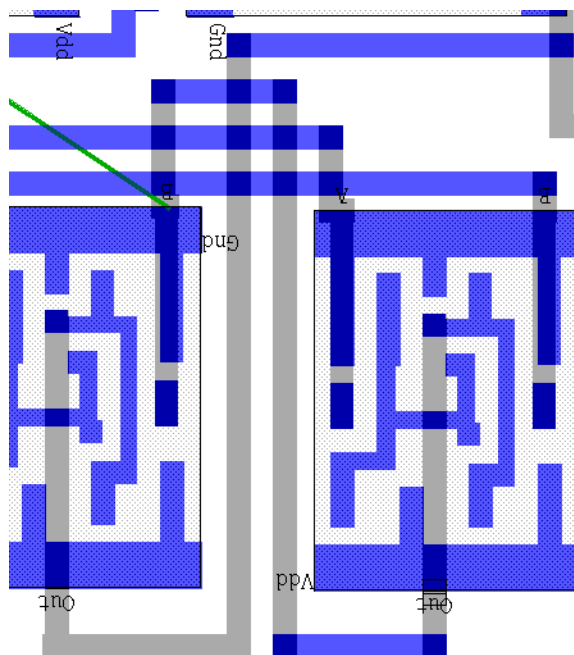


- ☒ Click and drag to the East with the left (DRAW) mouse button to draw the fourth wire segment horizontally on **Metal1**, as shown below.




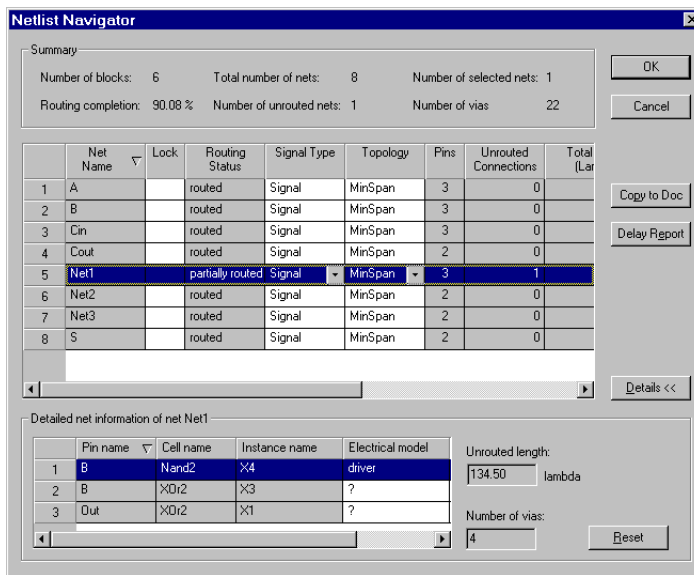
- ☑ Stop when the routing guide is aligned with the port labeled **Out**.
- ☑ Click the left (VERTEX) mouse button to add a vertex and press **F11** to cycle down the routing layers list to select **Metal2**.
- ☑ Press the left (DRAW) mouse button and drag the mouse North to draw the final vertical segment of the route.

- ☒ When your cursor is exactly over the routing port **Out**, click the right (END) mouse button to complete the wire segment as shown below.





Click on the **Netlist Navigator** button . Note that the **Unrouted Length** for net **Net1** (in the **Detailed net information** group) is **134.50** lambda and **Routing Completion** (in the **Summary** group) is **90.08%**.



Click **OK** to return to the layout.



Right-click on the Layers palette and select **Show All** to display all layers.

- ☒ Save the file as **Adder1Bit_placed_tutorial.tdb**.

This completes the assisted manual routing section of the tutorial.



Controlling Dialog Tables

The **Netlist Navigator**, **BPR Initialization**, and **BPR Setup** dialogs all contain tables. The behavior of these tables is subject to the following interface controls:

- The active row will have a highlight box around it.
- A selected row will have a different background color.
- Columns and rows can be resized by dragging the edge of their heading area.
- You must double-click in a field to enter or change a value.
- Drop-down arrows are visible only when a row is selected.
- Values cannot be sorted in drop-down lists that open inside a table.
- Delete removes an entire row without confirmation.

The **Netlist Navigator** supports the following additional table controls:

- Any column can be used to sort in ascending or descending order by clicking in the column heading area.
- You can select multiple nets. Use **Ctrl+SELECT** to extend selection to individual rows; use **Shift+SELECT** to extend selection to multiple consecutive rows.

- When multiple nets are selected, setting a field value will result in the new value being assigned to all selected nets. To change a value without losing your selection set, use **Ctrl+CLICK** on the field you want to change.
- When several nets are selected their background color will change; the row that is in focus will have a highlight box around it.
- Typing in the first column will move the selection to the first net with a name beginning with the letter typed.
- Slowly typing will cycle the selection through nets with names that start with the letter you have typed.