PULSONIX

High Speed Option

Users Guide

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Printed in the UK. Issue date: 12/01/17 Pulsonix iss 8

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Chapter 1. Interactive High Speed Routing

Technology File and Rules Management

All rules for definition and management of the Interactive High Speed option are available within the Technology file under their respective rules headings. Each page enables you to set constraints and rules for each feature.

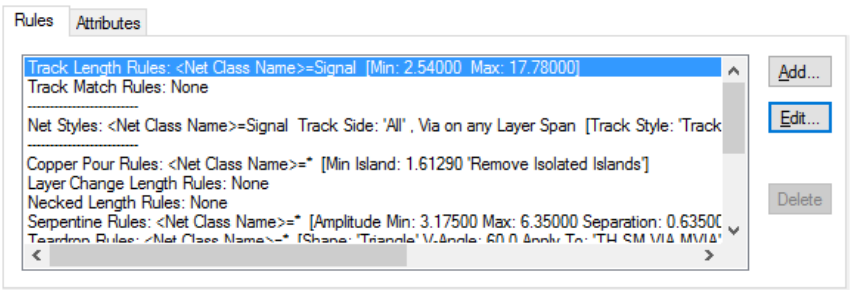
Rules & Attribute Windows

To introduce general functionality used throughout, the **Rules** and **Attributes** window is discussed below.

For each **Net** item page in the Technology that supports rules and attributes there is a tab for each rules type (**Rules** or **Attributes**).

Rules

This page will display all the rules associated with the selected net. Not only does it display the rule, but rules can be added, edited and deleted here too.



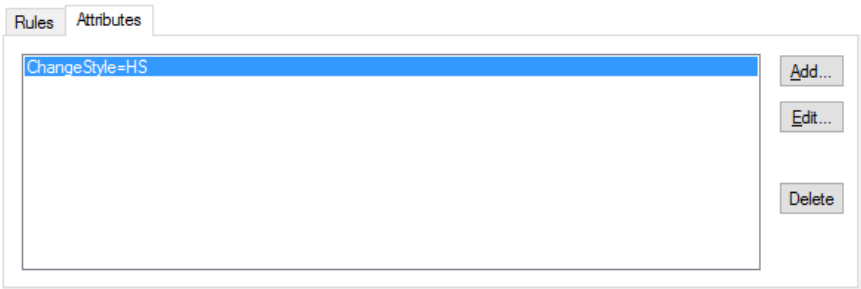
Add – this button is used to add a new rule for the selected rule item. By default, a new rule is created for <Net Name> and matching the net name selected, this is ready to add rule values to. The default net name rule is can be changed to your own criteria if required. If you press Add where the rule exists, it will edit the rule ready for a further edit.

Edit – for a selected Net item, where the rule is defined, it can be edited in its appropriate rules page. This button is greyed out if the rule doesn't exist.

Delete – use this to delete a selected rule. However, special conditions apply if the rule applies to more than one net item, the rule cannot be deleted. For example, if the rule is specific to <Net Name> CLK, then it can be deleted. If the rule applies to CL*, then it could belong to CLK and CLK1, in which case it cannot be deleted. The rule can be deleted of course from its own rule dialog.

Attributes

Net Attributes can be attached to a net. Rules can then be associated with that attribute. You might use an Attribute rule to attach to Nets that don't meet possible selection criteria. For example, a collection of nets that have different Net Names or different Net Classes but which still need **Track Length Matching** or a particular **Net Style** applied to them.



As with the **Rules** pane, there are buttons for **Adding**, **Editing** and **Deleting Net Attributes**. When adding an attribute here, if it is new to the design, it will be confirmed as being added to the **Attributes** dialog as well. This will be added as a Net Attribute for use on nets.

Once the attribute name has been added to the net, you must then create an appropriate rule for it to use. You may assign more than one Net to use this attribute. You may also assign more than one rule to an attribute so care should be taken if doing this.

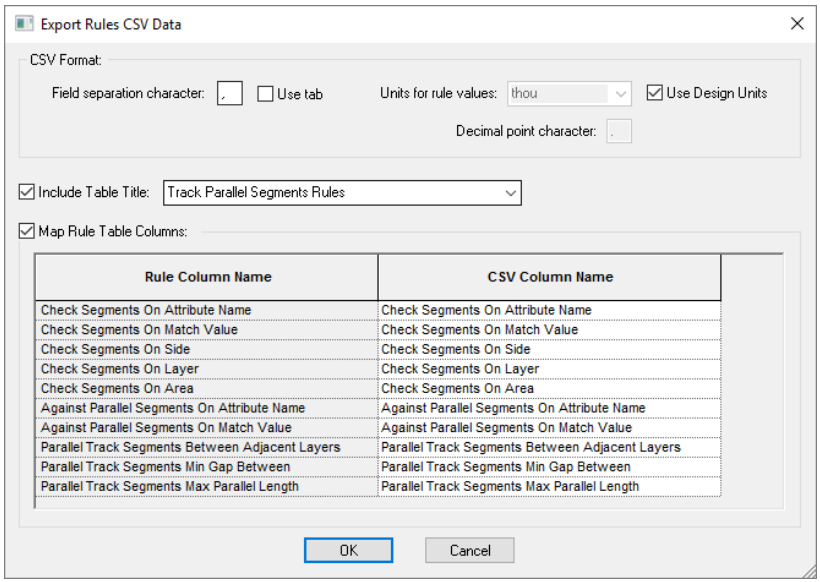
Import & Exporting Rules

Within the **Technology** dialog, the **Export CSV** and **Import CSV** options are available on dialogs for **DFM/DFT rules** and **High Speed rules**. This means rules can be created externally using Excel for example, and imported into Pulsonix. Export of rules allows templates for each rule set to be exported before modification and import.

These operate for each page and each set of rules. Each set of rules has its own column and row formatting to accommodate rules and functionality. You cannot combine CSV files for different sets of rules in the same design, you can however use the CSV file containing rules on different designs.

Exporting to CSV format

When the **Export CSV** button is pressed, the following dialog is displayed, this example shows the dialog for the Track Parallel Segment Rules:



Headers for each type of CSV file are the same but **Table Columns** change for each one.

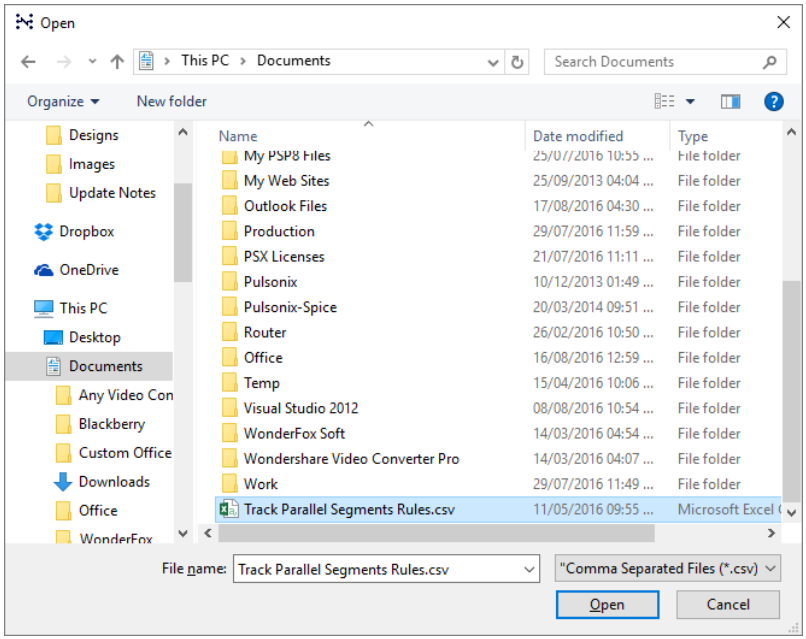
CSV Format – the contents under this header allow you to format the CSV file so that regional variations on the data format can be used.

Include Table Title – this is used if you wish to include a title as the first line in the CSV file. You might wish to do this to identify the rule being exported or the design name for example. By default it will display the name of the rule but you can type over this to enter your own title.

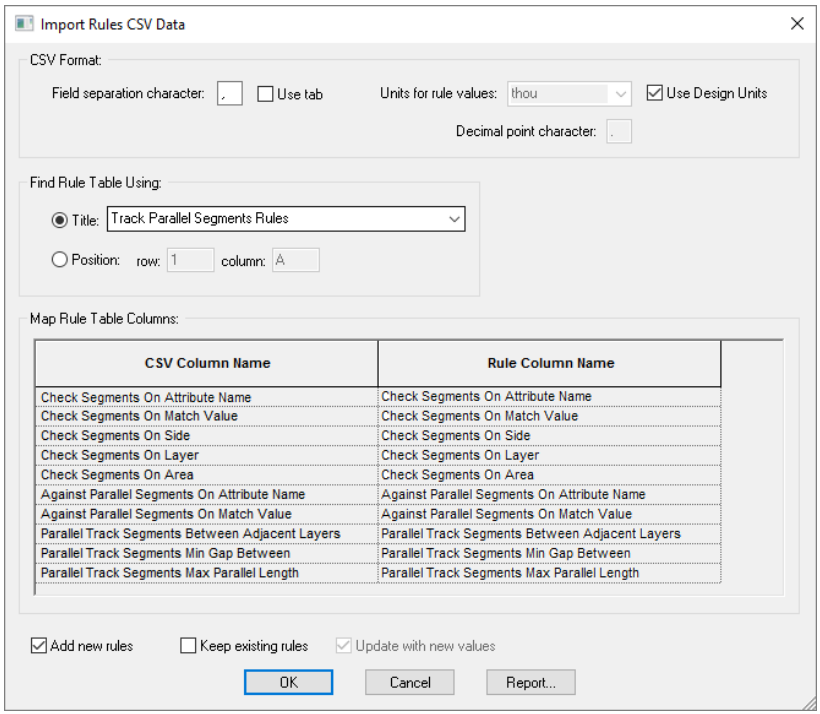
Map Rule Table Columns – this allows you to map the rule name being exported into the CSV file using either default column names provided or your own typed column names. These names appear in the CSV file, it may be that you wish to use shorter or abbreviated names or names in your local language.

Importing CSV format files

When the **Import CSV** file button is pressed, you are presented with a standard **Open** dialog from which to choose the file for import:



Once the file has been read, you are presented with an **Import CSV** dialog. From here, you can inform the program on how the CSV file has been **formatted**, whether it uses a **Title** header or not and the ability to map the incoming **Columns** names against the ones expected in the **Technology** dialog.



There are three check boxes which when used in conjunction with each other will allow you to customise the way rules in the CSV file are imported and what happens in the event of new and exist rules found.

Add new rules – allows you to add new rules from the CSV file. Using a combination of the check boxes below will determine what happens if the rule already exists.

Keep existing rules – If a rule is imported and it already exists you can keep it (as is) or by selecting the check box below, will allow you to update the rule value.

Update with new values – use this check box if you wish to update an existing rule with new values from the CSV file. This option is only available if the **Keep existing rules** check box is selected.

Report

The **Report** button on the import dialog will check and report the contents of the CSV file to be imported. The summary presents you with the number of rows found, this acts as verification and any errors found. Errors will include name or syntax errors within the file.

```
Import CSV Rules
-----------------
Report Written : 17/08/2016 04:33:20 PM
Design Path    : C:\Documents\HS Diff Pairs.pcb
Design Title   :
Created        : 25/10/2015 02:46:34 PM
Last Saved     : 14/01/2016 05:31:55 PM
Editing Time   : 588 min
Import File    : C:\Documents\Track Parallel Segments Rules.csv
Import Summary
--------------
Rows Found : 6
Errors Found: 0
```

Format of the CSV File

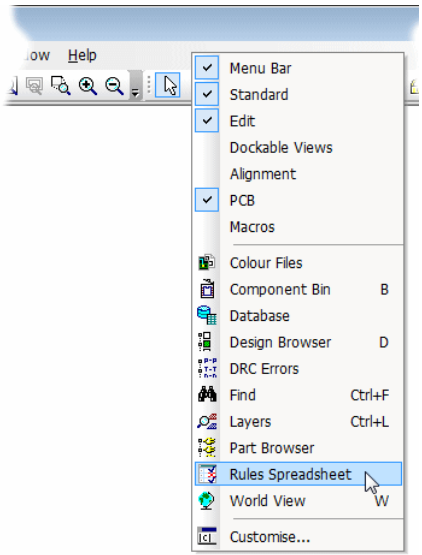
CSV files can be exported to provide you with a ‘base’ file formatted in the expected Pulsonix format ready for modification and subsequent import. You may also create CSV files from Excel for example using the appropriate format. Again, exporting an empty rules page in CSV format first will give you a blank data template to work with.

When editing values in the CSV file, the names used must match names as they appear on the dialog itself. For example, a layer side name of Top, Bottom, Inner or Outer is acceptable but Solder or Component would not be.

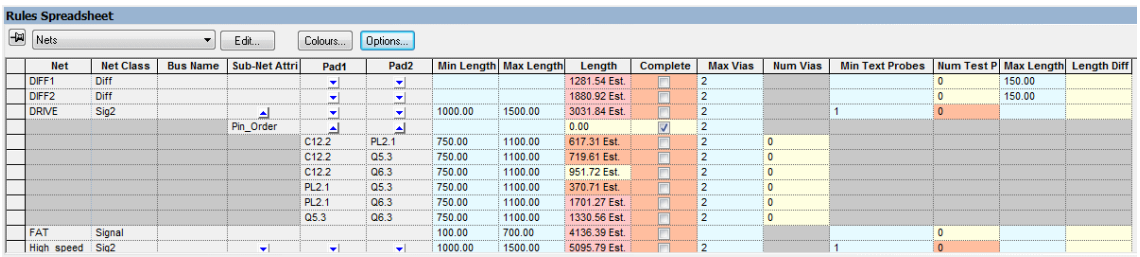
Rules Spreadsheet

As part of the **Interactive High Speed Rules** option, the **Rules Spreadsheet** dockable PCB bar displays information about Nets, their rules and where the rules are being violated. The display is updated dynamically as tracks are added and edited.

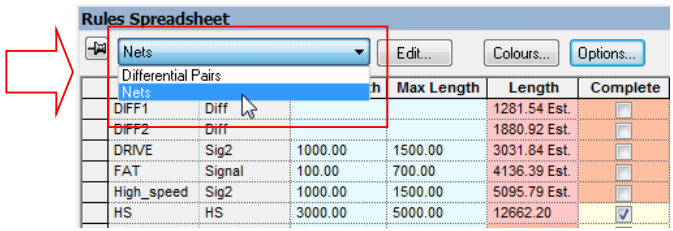
This option is available as the **Rules Spreadsheet Bar** on the **View** menu or from the context menu when right-clicking on the Pulsonix framework.



It is presented in the form of a spreadsheet in a dockable bar, you can switch between different information content.



Differential Pairs and **Nets** are available for selection on the drop down list.

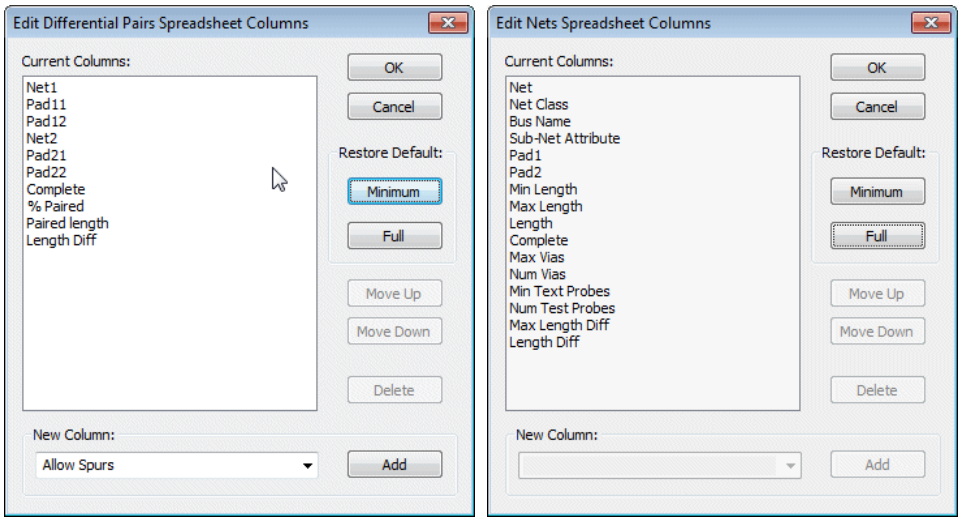


Choosing the spreadsheet type

Use the dropdown list in the dialog header to set the current spreadsheet type, or if the list is not visible select the required spreadsheet type from the shortcut menu. Choose between displaying a list of **Differential Pairs** or a list of **Nets**. Differential pairs have one row per item, whereas Nets can have additional rows to display sub nets (defined by pin attribute) or to display pin pairs in the net. The existence of these rows depends on which columns have been included. The additional rows can be shown or hidden by pressing the small triangle icon in the owner row above them.

Rules Spreadsheet Edit

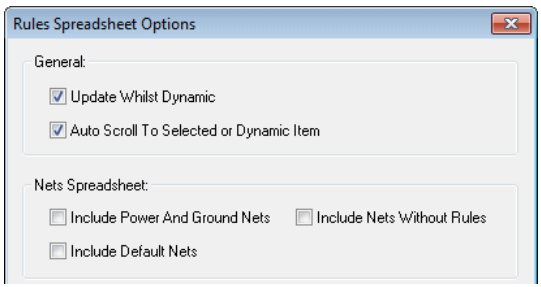
The **Edit** button is used to define what information (columns) are shown in the rules spreadsheet grid.



Using the **Minimum** button allows you to select a minimum number of fields to display. The **Full** button shows a more complete list. Both lists can be enhanced by selecting additional fields using the **New Columns** button and using the **Add** button to add them to the list. Once chosen, the order can be moved using the **Move Up** and **Move Down** buttons. Use the **Delete** button to remove the field from the display list.

Rules Spreadsheet Options

The **Options** button is used to set up your preferences for the rules bar behaviour and to specify which items are not to be included. If the button is not visible, Use **Spreadsheet Options** from the shortcut menu. The options are retained in the system registry so that your choice is preserved for future use.



Update Whilst Dynamic - Generally information in the spreadsheet is updated as soon as items in the design are changed. For large nets on some designs this can take a while, especially whilst placing items and adding track segments. Unchecking this box will stop the "continuous" updating that happens whilst moving items during interactive operations, and they will only be updated when the item is dropped or a corner is added. Leave the box checked if you want to see the track length changing "on the fly" as you move across the board, for example if you are using the spreadsheet instead of the head up track length display on the cursor.

Auto Scroll to Selected or Dynamic Item - Check this box to ensure the current item in the design is always visible in the spreadsheet by automatically performing a vertical scroll.

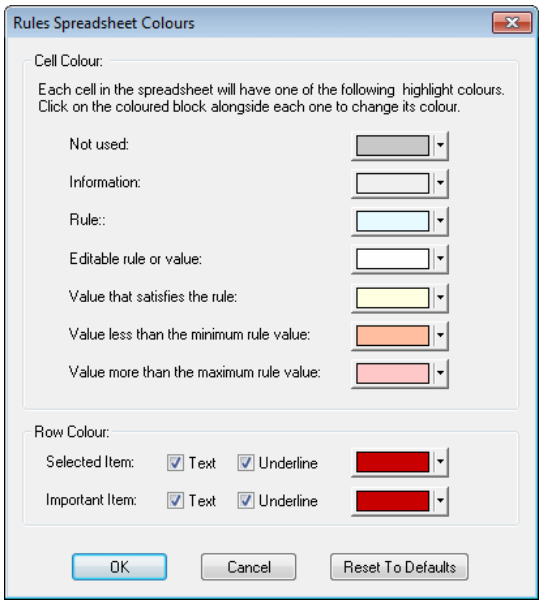
Include Power And Ground Nets - Check this box if you want to include nets that use a net class with type power or ground. These nets are often not required as net track length is not an issue with them. They usually have a lot of nodes and can take a long time when calculating values, like completion for example, as they need to check planes and poured copper.

Include Default Nets - Check this box if you want to include nets that don't have a user defined net name.

Include Nets Without Rules - Check this box if you want to include nets that don't use a net class containing track, via or probe rules. These nets are not normally required in the nets spreadsheet as they have no rules to check against.

Rules Spreadsheet Colours

Use the **Colours** button to change the colours of the spreadsheet cells, and to define how to highlight the row that represents the item that is currently selected or being edited in the design. If the button is not visible, Use **Spreadsheet Colours** from the shortcut menu. All colours in this dialog are retained in the system registry so that your choice of colours is preserved for future use.



The top section shows a set of colour buttons showing the colours that will be used for each cell information type. Click on a colour block to change its colour.

Not Used - This colour is used for cells that are not needed, i.e. their column is not relevant for their row. For example the "Net Name" cell on a pin pair row.

Information - Used for cells that represent non editable information about the row's data item, that is not directly associated with a rule. For example the two net names for a differential pair.

Rule - This colour is used for non-editable values that represent a rule limit. For example the maximum track length for a net. To change these values you must visit the appropriate dialog in the technology.

Editable rule or value - Used for values that are editable. These usually represent a rule limit that is directly editable in the spreadsheet (like the differential pair rules) or an information cell that you can alter to change what data its row represents (pin name cells in a pin pair row on a large net for example).

Value that satisfies the rule - This colour is used for values that are within their corresponding rule limits, and therefore represent a rule pass. For example a nets track length that is within the defined minimum and maximum rule values.

Value less than the minimum rule value - Used to highlight values that fall short of their corresponding minimum rule limit. For example a pin to pin track length that is less than the minimum pin to pin length defined for a net, or a net complete cell on a net that has tracks missing.

Value more than the maximum rule value - Used to highlight values that exceed their corresponding maximum rule limit. For example a pin to pin via count that is greater than the maximum number of vias allowed between pins on the net class.

The lower section shows how the selected or important items in the design have their rows highlighted in the spreadsheet. For each highlight type you choose a colour that will be shown as a block in the first column of the row, and choose whether the text in the row is displayed with this colour, and also if the row is underlined with the colour.

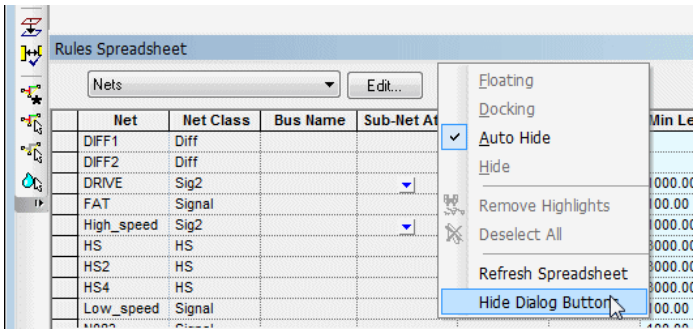
Selected Item - This row represents the single net or differential pair in the design that is selected, or a part of it that is being edited (a track being edited for example).

Important Item - These rows represents nets or differential pairs that have been marked as important in the spreadsheet. See above for information about highlighting rows for important items.

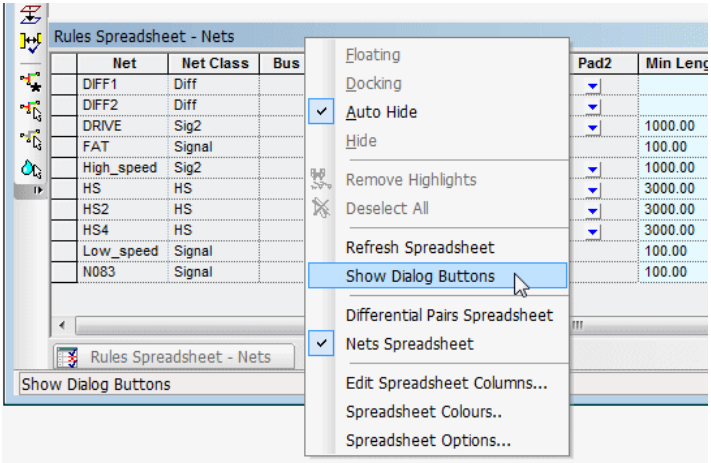
The **Reset To Defaults** button will return the colours and highlight check boxes to their original "factory" settings.

Hiding Dialog Buttons

You can maximise the space available for the spreadsheet grid by using **Hide Dialog Buttons** from the shortcut menu to remove the dialog controls above the spreadsheet and move the spreadsheet up.

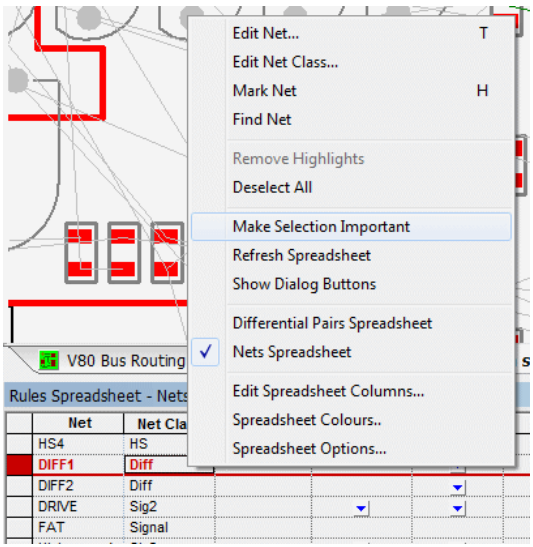


The **Show Dialog Buttons** option will reverse this. When hidden, you can still change the spreadsheet colours, options and columns by using commands on the shortcut menu. If the buttons are hidden, the title of the bar will include the spreadsheet type.



Highlighting important items

Using left click in any cell in the first column that represents a differential pair or net (i.e. not a sub row) will mark the item the row represents as "important" to you. The row will be highlighted to enable you to quickly see the information whilst editing the design. You can specify how the row is highlighted using the spreadsheet **Colours** dialog. Use **Remove Important Items** from the shortcut menu to clear the spreadsheet of any highlighting of important items. Use **Make Selection Important** from the shortcut menu to highlight all rows that have selected items in the design.



If a single differential pair or net is selected or is being edited, the row will be highlighted as the "selected" row. How the selected row is highlighted is defined in the spreadsheet **Colours** dialog. There is a spreadsheet option (see below) to ensure that the selected row is always scrolled to be visible.

Nets and Rules in the High Speed Option

Nets Items

This is brief introduction to Nets, Diff Pairs, Diff Pair Chains, Signal Paths, Sub Nets and applying rules to them.

Within the **Technology**, there are pages in the **Nets** section for defining facets that are properties of a net or multiple nets, Signal Paths, Sub-Nets, Differential Pairs and Chains of Differential Pairs. Each of these net items can have attributes assigned and rules added to them.

Why and when to use each category

To summarise each category, here is what they are used for in Pulsonix:

Standard net items

Nets – All Nets (Connections) within the design have a **Net Name** with a **Type** *(see special note below about Type)* and (optionally) a **Guard Space**. They can also have a set of attributes containing rules added, for example, a **Track Length Rule.** They can also have an optional **Net Class** associated with them. Net Names can be user defined or default names automatically assigned by Pulsonix.

Net Class – Net Classes have a **Net Class Name**, a **Type** and a flag to **Mark All Nets As One**. It also contains Net Class based **Track Length Rules**. A Net Class is an alternative method of 'grouping' nets to which the same parameters can be associated. This is a general method for grouping categories of nets but can be achieved more efficiently using alternative methods. Nets do not require a Net Class, all rules can be attached to a single net or multiple nets.

Net Styles – All default [physical] styles (Tracks, Vias etc.) associated with a Net Class or Net Attribute are defined in the **Net Styles** dialog. This dialog is also used to define how tracking will behave on different **Layers**, within **Areas** and for **Layer Spans**.

Net items for the High Speed Design Option

Signal Paths – Signal Paths represent another level of net definition. The path is a named item containing an ordered list of pads that represent a signal path. You might use this within High-Speed designs for example where constraints are required. This could be where the overall track length of the signal path would require a specific defined length rule(s).

Sub Net – These define part of a net which may require special considerations. These are defined in the **Sub Nets** dialog using an **attribute name** and **value**. Pins on the same net with attributes that match it are deemed to be in the same sub net. One definition can define sub nets in multiple nets. You may use this for example, when creating branch lengths or a specific daisy chain order in a High Speed design.

Differential Pairs – The Differential Pairs dialog is used to define the Differential Pin Pairs and Differential Pair Chains (see below). All other Differential Pair specific rules such as **Pair Gap** and **Pair Length** are contained in their own dialog under the **Rules – High Speed** section.

Differential Pair Chain – A Differential Pair Chain is two or more (existing) Differential Pairs added to a named list to create an extended list. This is used for associating multiple Differential Pairs so that lengths or net rules can be defined for the overall 'path'. This path may be split with a terminating component for example and will contain different net names. As with Differential Pairs, a design can contain multiple Differential Pair Chains.

Type – *a net always has a Type, this is assigned when the net is introduced to the design. It can be one of three states; Power, Ground or Signal. Type is used for some net-based options such as Optimise, Design Rules Checks, ERC and Autoplace.*

Rules

What is a rule?

A rule is a collection of specific conditions and characteristics that can be assigned to a net. Whereas previously these rules were bundled to be set on Net Classes, they are now individual facets that can be assigned to any net or sets of nets. Rules are attribute driven. Some 'rules' are system 'attributes' such as <Net Name>, <Net Class> etc. but user defined attributes can be added as well.

User defined attributes would be created when system attributes do not provide enough range for rules coverage. For example, a Track Length rule might be applied to multiple net names that do not have a common name format, like CLK, RST, DQ1, ADD3 etc.

What characteristic might a rule have?

Rules can be standard items such as Copper Pour, Thermal connectivity, Teardrops and Net Styles etc. More advanced rules might include facets such as Track Length, Track Length Match, Serpentine and Track RF features so mention a few.

What can a rule be assigned to?

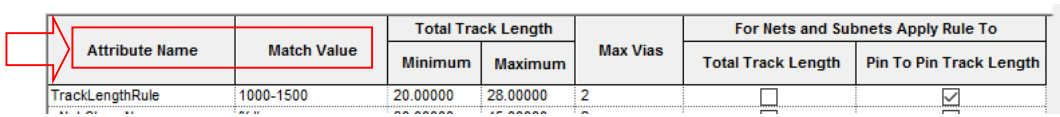
Rules can be assigned to any Net, Signal Path, Sub-Net, Differential Pair and Differential Pair Chain. This means one (or multiple) rules can be applied to multiple net categories. For example, a number of Thermal rules can be defined and applied to all signal or power style nets. Likewise, a Track Length Match rule can be applied to multiple sets of Differential Pairs to ensure they are all within length difference of each other.

Rules may also still be assigned to a Net Class if required but with this style of rules structure is less likely to be used this way.

In addition to assigning rules to Net items, in the Thermal Rules and Teardrop Rules dialogs, you can also assign rules to <Pad Style Name>. This means specific rules can be added for pad or via styles for ranges or specific pads.

Key headers used in the rules dialog

There are some essential headers that are used within the rules dialogs and are highlighted below:



Attribute Name	Match Value	Total Track Length		Max Vias	For Nets and Subnets Apply Rule To	
		Minimum	Maximum		Total Track Length	Pin To Pin Track Length
TrackLengthRule	1000-1500	20.00000	28.00000	2	☐	☑

Attribute Name – this is the name of attribute that will define the rule, for example, this could be one of the system 'attributes' such as <Net Name> or <Net Class Name>, or it could be your own user-defined attribute name, such as TrackLengthRule

Match Value – once an Attribute Name has been defined, you must give it the name of something to match. This could be a unique Net Name, CLK for example, or a range of Net Names to apply the rule to, such as ADD0 to ADD9. Using Ranges to match the attribute means a single rule can be applied to multiple instances.

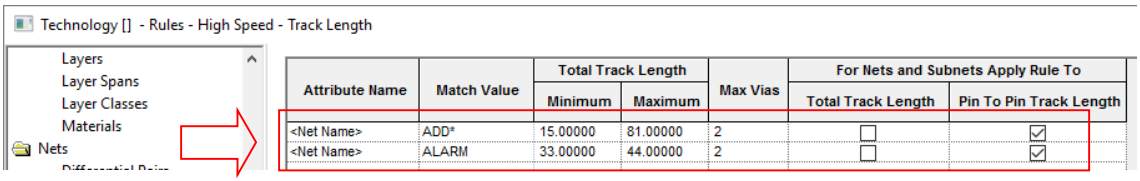
Creating and applying Rules

Rules can be created and applied using two methods:

Method 1

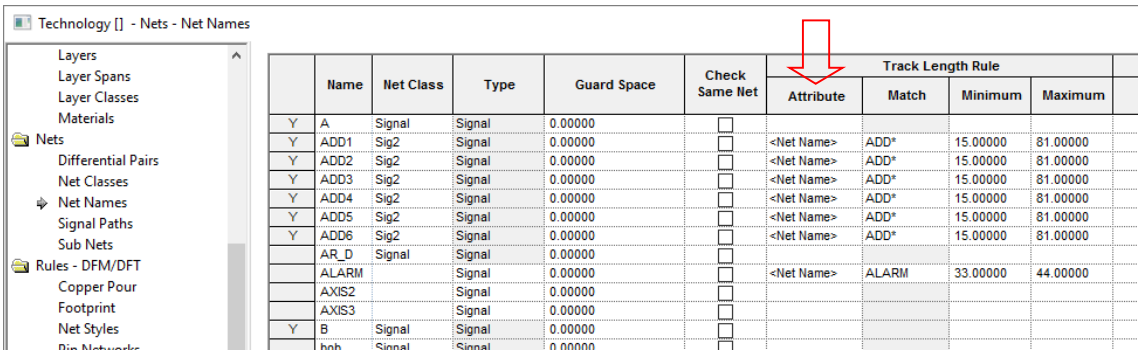
Create your rules first in the Rules sections (in the Technology dialog under DFM/DFT and High Speed) and apply them to the net(s) required.

As an example, we'll show the addition of a **Track Length Rule** but the principle applies to all rules. Create the rule by adding an **Attribute Name** and **Match Value**, plus your rule **values**:

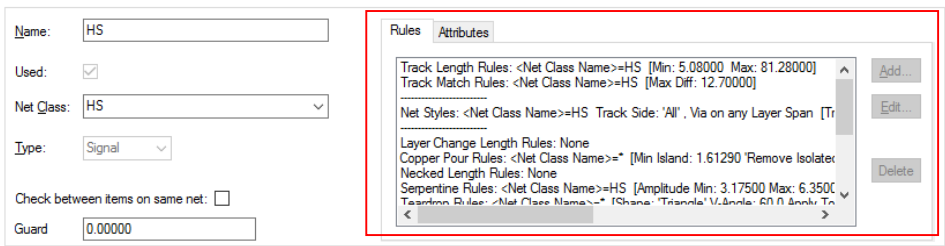


On the **Nets** page, if the new attribute matches the rule, the attribute name and value will be automatically adopted. If the rule doesn't match automatically, apply the rule by typing the rule name in the **Attribute** field (or selecting it from the drop down list which will be populated from the list of available rules).

The example below is specific to the **Track Length** rule as this is directly shown in the **Nets** dialog:



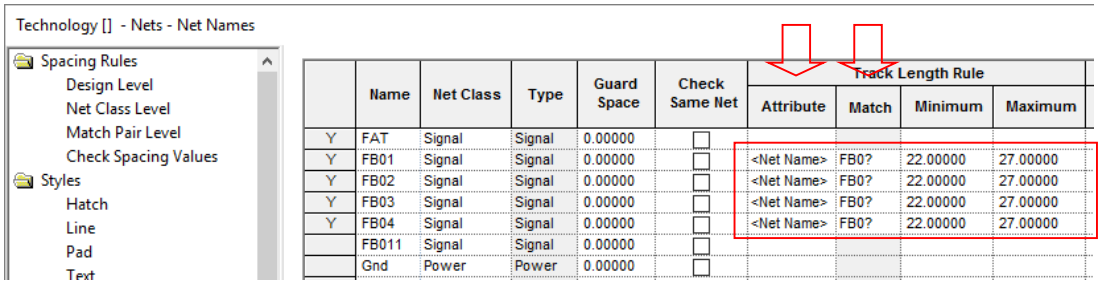
All rules added to a net-based item are displayed in the relevant dialog in the **Rules** and **Attributes** tabs:



Method 2 – Track Length Rule & Track Length Match Rule

When using the **Track Length Rule & Track Length Match Rule**s, an alternative is to write the rule directly into the dialog that requires it (Net Name, Net Classes, Signal Paths and Sub Nets). Once the attribute (Rule) is written, it then becomes a rule within its own right and appears in the relevant Rules page where it is available for use on other nets.

To do this: write the rule into the **Attribute** cell along with the **Match** and **Values** to be used. In the example below, the <Net Name> system attribute has been selected. The typed Match will be FB0? And values of 22.0 and 27.0 for Min and Max Track Lengths respectively. This then matches the Net names FB01-04 but not FB011 (? will only match one character).



Using Attribute Rules

Once Attribute Rules have been defined, they can be matched on a net item by Rule Value or by Rule Name depending on which scheme best matches your requirements.

Match the rule value - any item with the rule attached and matching the value. For example Attribute Name=TrackLength, Match Value=2.0. Where a net then contains an attribute of TrackLength and a Matched Value of 2.0, the rule will be applied.

Match the rule name - any item with the rule attached, with no value (%# must be used as the value to show a field with no value), but match by rule (attribute) name.

Rule Matching Examples

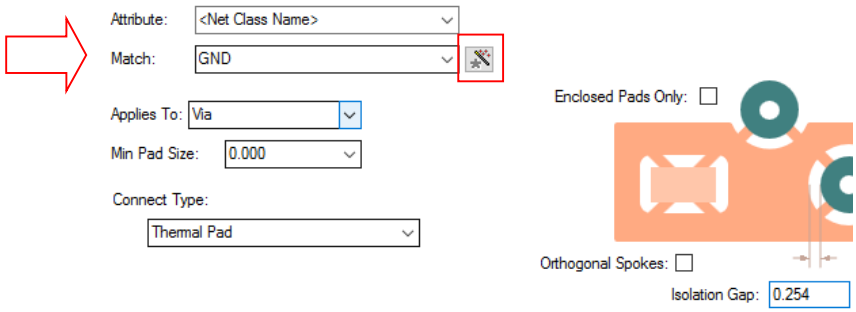
Wildcards are a powerful way to create ranges for selection, below shows a selection of wildcard ranges:

Attribute Name (Rule)	Match Value	Rule Values	Description
<Net Class>	Signal	xx	A specific Net Class name of Signal has the rule applied (where xx is your rule value)
<Net Name>	DQS*	xx	Any net starting with DQS
<Net Name>	DQS%[1:7%]	xx	Any net between DQS1 to DQS7
<Differential Pair Name>	%{DQS*|DSM*%}	xx	Any Diff Pair starting with either DQS or DSM will have the rule applied. The strings are separated by a pipe (|) character.
TrackLength	2.0	xx	Any net that has the attribute with the name TrackLength matching a value of 2.0 will have the rule applied.
TrackLength	*Blank* (will be written as %#)	xx	Any net with the attribute name TrackLength with no value will have the rule applied.

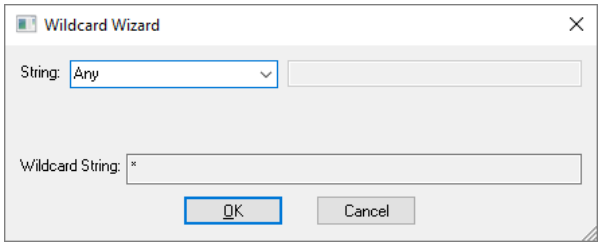
Wildcard Wizard

When a wildcard needs to be defined to create name ranges, you can use the **Wildcard Wizard**. This allows you to create wildcards, often, complex wildcard strings (or simple ones), that are presented in non-programming terms.

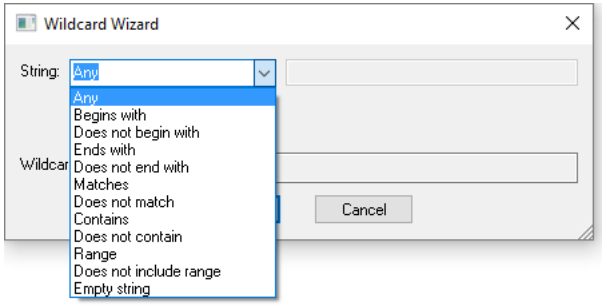
On dialogs where wildcards are accepted, there is a button to access the wizard.



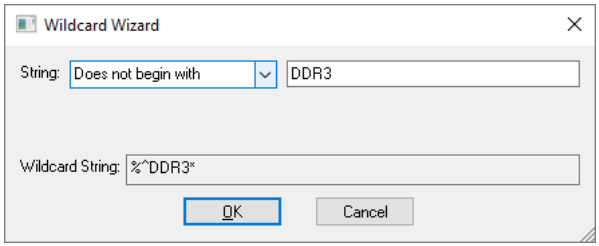
Pressing the button opens up the **Wildcard Wizard** dialog:



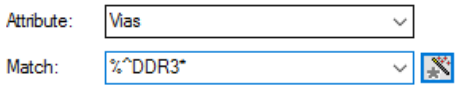
Wildcard String expressions are defined from the drop down list:



On selection of a **String**, you can type in the value to match. The **Wildcard String** is shown in the Wizard dialog.



When **OK** is pressed, the wildcard string is shown as the **Match** value back in the host dialog.



Signal Paths

What is a Signal Path?

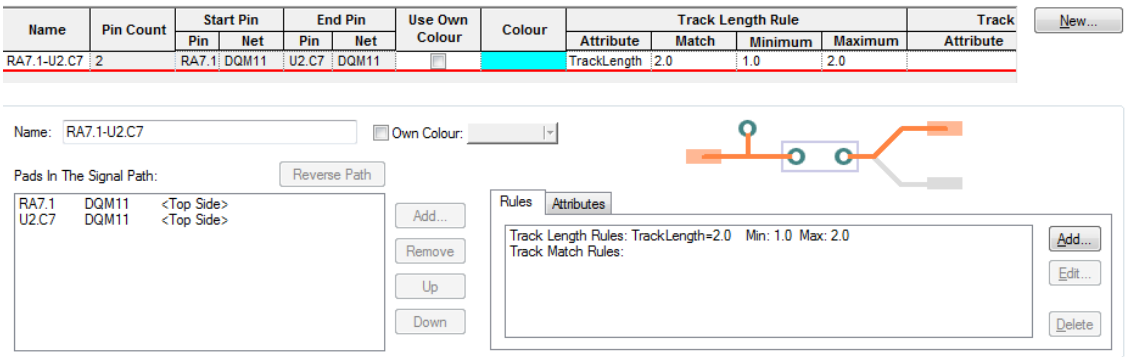
Signal Paths represent another level of net definition. The path is a named item containing an ordered list of pads that represent a signal path. For example, you can use this for High-Speed designs where constraints on specific signals are required or for defining portions of a net where specific rules should be applied, such as Thermal or Copper Pour Rules.

The difference between a rule on a Net and the same rule on a Signal Path is that the signal path can be just a portion of the net (or multiple nets), whereas, a net rule is applied to a whole net.

The **Signal Path** dialog is used from within the **Technology** and provides an interactive mode and modeless dialog to create signal paths.

Using the Signal Paths dialog

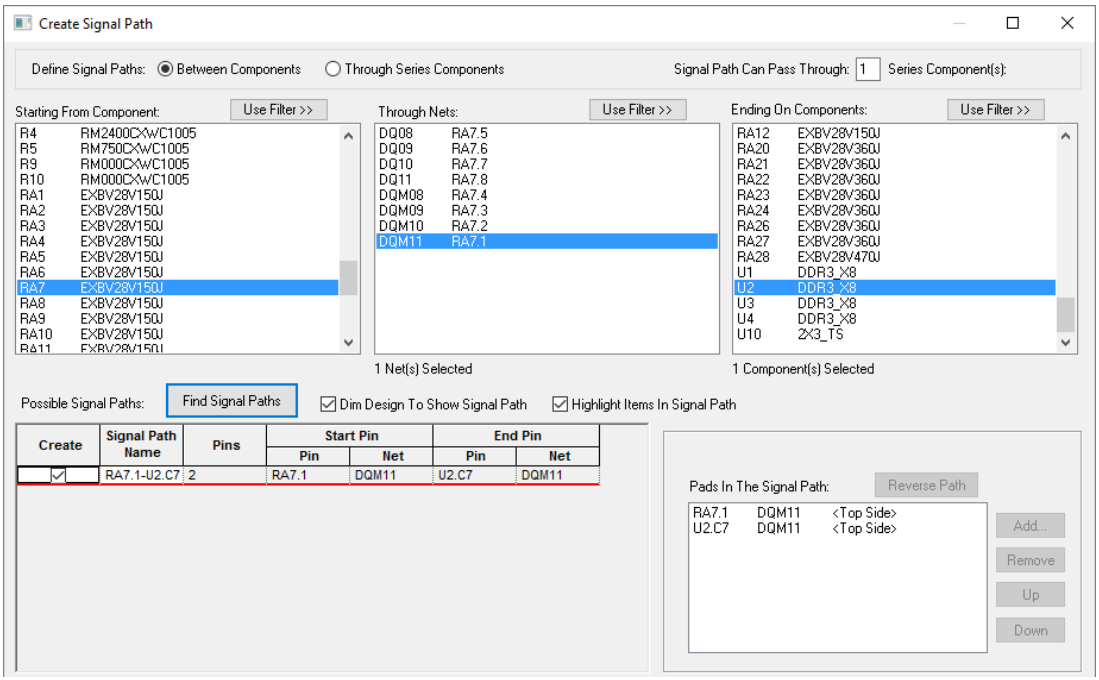
Signal paths are added in the Signal Paths page within the **Technology** dialog. From this page, **Track Length** and **Track Match Rules** can be applied if required or you can use the Signal Path name within other rules, such as **Net Styles**, **Serpentine Rules** or **Thermal Rules** etc.



There are two dialogs to this function; the main dialog for managing the rules and the secondary dialog to create the signal path. The dialog above is the management dialog.

The dialog below (the signal path chooser) is for signal path creation and is activated from the Signal Paths dialog. It enables you to search for signal paths between two chosen Components, or signal paths that pass through a selected series Component. These items can be selected in the lists at the top

of the dialog, or interactively in the design. A signal path doesn't necessarily have to be a direct path through pins and can be 'split' through a series component.



Creating Signal Paths

The **Signal Path** selection dialog can be invoked using the **New** button from the **Signal Paths** dialog or from the context menu when a component or pads on a component(s) are selected. This dialog will provide you with **Start** and **End** Component pins and connecting nets (**Through Nets**).

A Signal Path doesn't have to be on the same net (it can be though) but when split, can be through a component. You can choose the radio button **Through Series Component** to refine the component pin selection and choose to how many series components the **Signal Path Can Pass Through**.

Once your signal path has been chosen, press the **Find Signal Path** button to add it to the **Possible Signal Paths** list. This will display your choice in the grid. As you select a row in the grid, the pads, connections and tracks in the signal path are displayed in the design.

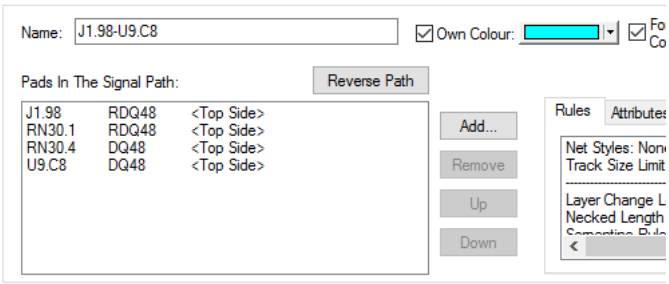
If satisfied with the signal path displayed, press the **Create** button. If this is your only selection at this point, press **OK** or **Apply** to add the selection to main Signal Paths dialog. If not satisfied with the selection, leave the Create button unchecked and make a new selection in the chooser.

There are additional check boxes on this dialog to assist with the display and selection of items chosen. The **Dim Design To Show Signal Path** check box is used to dim all other items so you can easily see the signal path. Likewise, use the **Highlight Items In Signal Path** to make the selected items stand out. This can be used in conjunction with the **Dim Design** button.

Signal paths that are already defined in the main **Signal Paths** dialog will be indicated and changes disabled.

Press **Apply** or **OK** to add the signal paths as entries in the design. Each component pad in the path will be remembered and along with its order with the path.

Once a Signal Path has been created, the main dialog presents you with edit controls for the current signal path in the grid.

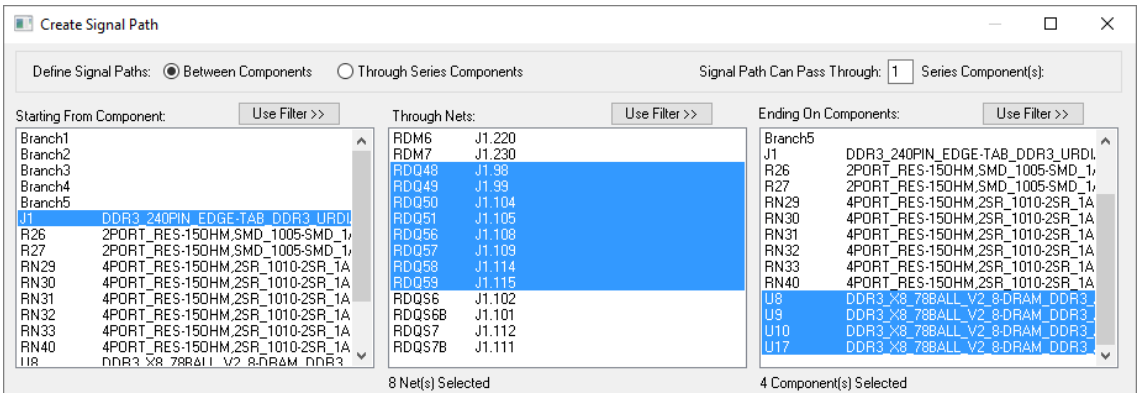


Use these to indicate you want to create the path, apply a name for the signal path and allocate a track length and length match rule to it. If the path is to pass through more than two pins within a particular net, the extra pins can be added into the correct place in a pad list.

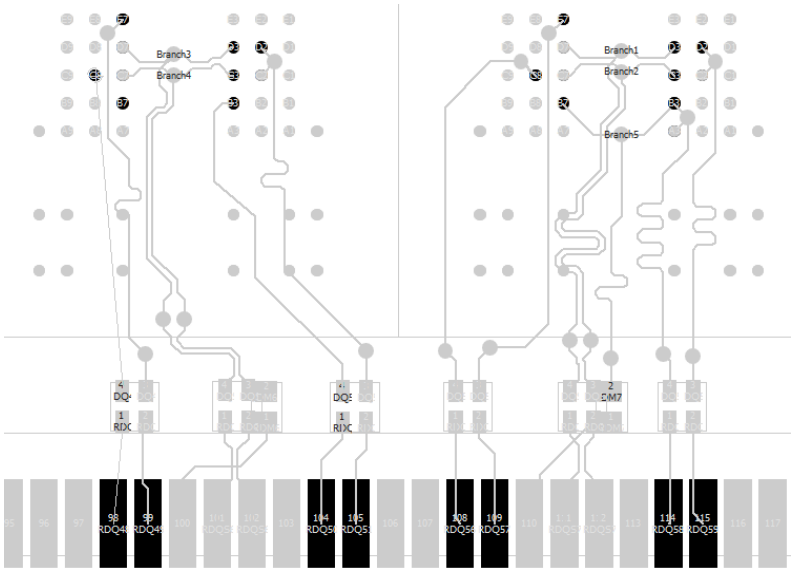
Adding Multiple Signal Paths in one hit

Multiple signal paths can be created at the same time.

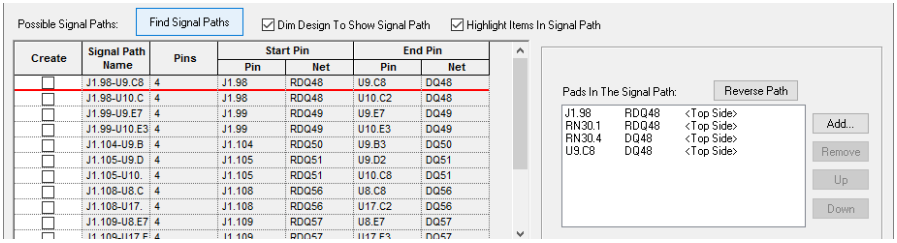
In the example below, Connector J1 has been chosen as the **Start Component**. As it happens, this has all the nets required exiting from it. You must then choose the nets required for the paths in **Through Nets**. Multiple nets can be chosen at one time by dragging down the list or using standard Shift/Ctrl combinations. Likewise, you can make multiple selections in the **Ending On Components** list. Choose the components required.



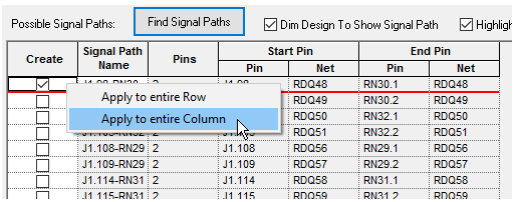
With this selection made, with the design dimmed, the proposed signal paths are displayed. You can use zoom and pan to navigate the design at this point.



When the **Find Signal Paths** button is pressed, the signal paths are added to the list of **Possible Signal Paths** if paths are available.



To create the signal paths required, press the **Create** button. If all are required as would be in our example above, use **Create** on one cell and right click. Choose **Apply to entire Column** to select all columns.



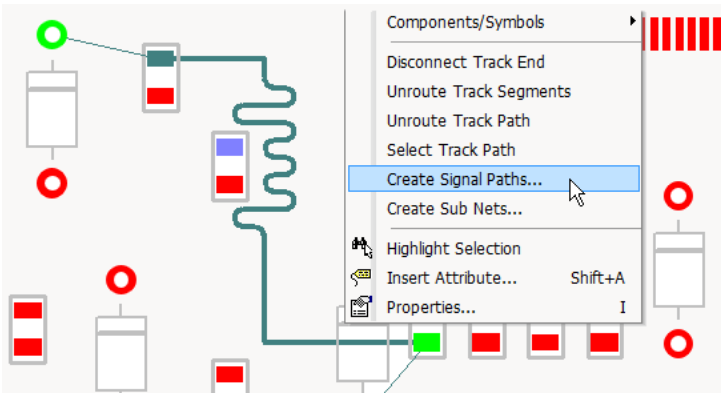
Once created, the main dialog displays the Signal Paths:

Name	Pin Count	Start Pin		End Pin		Use Own Colour	Colour	Display Connection	Track Length Rule			
		Pin	Net	Pin	Net				Attribute	Match	Minimum	M
J1.102-RN33.2	2	J1.10	RDQS6	RN33.	RDQS6	☐		☐	<Signal Path N	J1*	12.000	13
J1.104-RN32.1	2	J1.10	RDQ50	RN32.	RDQ50	☐		☐	<Signal Path N	J1*	12.000	13
J1.105-RN32.2	2	J1.10	RDQ51	RN32.	RDQ51	☐		☐	<Signal Path N	J1*	12.000	13
J1.108-RN29.1	2	J1.10	RDQ56	RN29.	RDQ56	☐		☐	<Signal Path N	J1*	12.000	13
J1.109-RN29.2	2	J1.10	RDQ57	RN29.	RDQ57	☐		☐	<Signal Path N	J1*	12.000	13
J1.114-RN31.1	2	J1.11	RDQ58	RN31.	RDQ58	☐		☐	<Signal Path N	J1*	12.000	13
J1.115-RN31.2	2	J1.11	RDQ59	RN31.	RDQ59	☐		☐	<Signal Path N	J1*	12.000	13
J1.98-RN30.1	2	J1.98	RDQ48	RN30.	RDQ48	☐		☐	<Signal Path N	J1*	12.000	13
J1.99-RN30.2	2	J1.99	RDQ49	RN30.	RDQ49	☐		☐	<Signal Path N	J1*	12.000	13

From here, you can add **Track Length** and **Track Length Match** rules.

Interactively Creating Signal Paths

In select mode, you can select two pads on the same component and use the context menu option **Create Signal Paths** to create signal paths through the selected component, forcing it to be treated as a series component.



Once selected, the **Create Signal Path** dialog is available with the signal path preselected from where you can use the **Find Signal Paths** button to select the signal path. This entry will then be added to the **Signal Paths** within the **Technology**.

Sub Nets

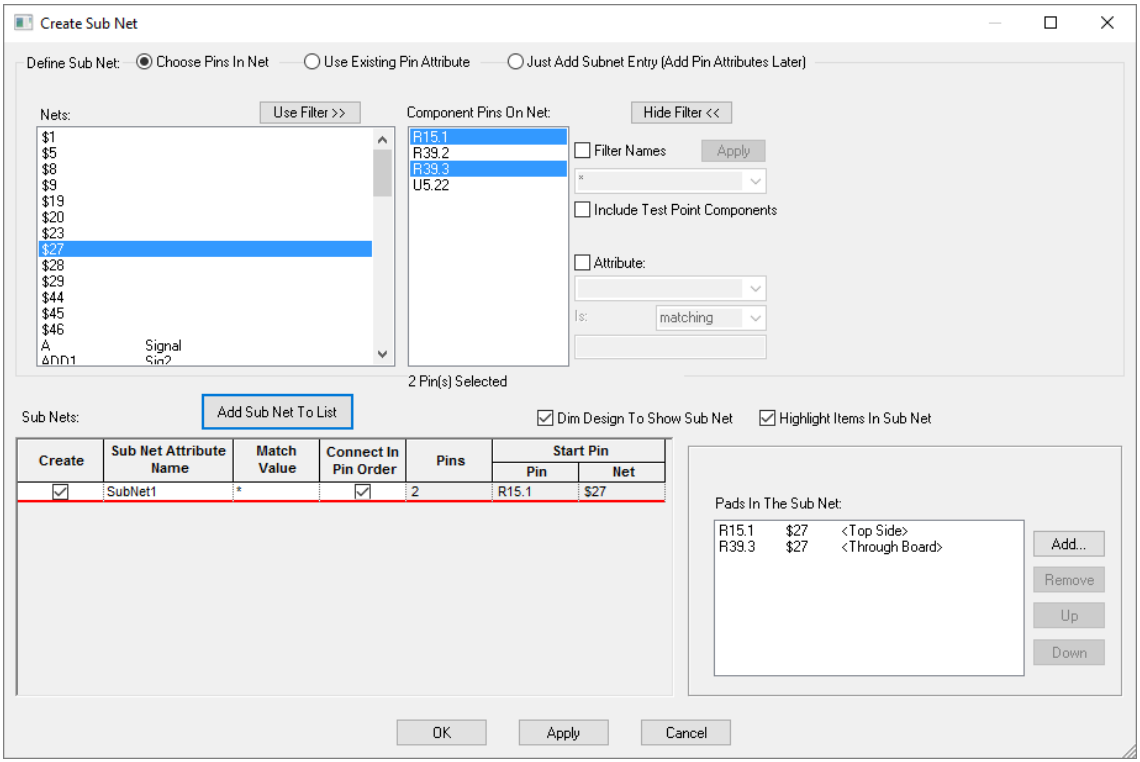
Overview

Sub Nets define part of a net which may require special considerations. For example, it allows you to create rules for portions of a net such as a specific pin order (Daisy Chain), or to use attributes on a net to define rules. It also allows you to use portions of a net to use a specific style (i.e. track thickness) and for copying ‘channels’ of functionality that have net branches and require matching.

Within the **Technology**, Sub Nets are defined in the **Sub Nets** dialog using a pin **attribute name** and **value**. Pins in the same net with attributes that match it are deemed to be in the same sub net. One definition can define sub nets in multiple nets. You may use this for example, when creating branch lengths or a specific daisy chain order in a High Speed design.

Creating Sub Nets

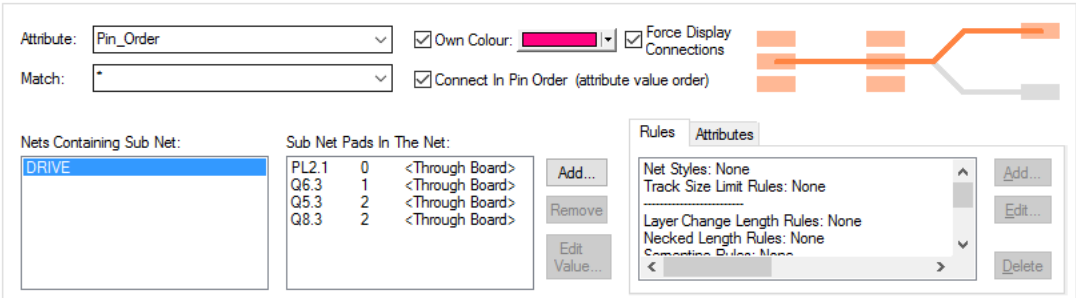
A new tool provides an interactive mode and modeless dialog to create sub nets. It can be invoked from the **New** button in the **Sub Nets** page within the **Technology** dialog. It can also be accessed from the context menu when a component pin(s) or net is selected.



You can define sub nets by selecting a list of **Pins In a Net**, or you can choose an **Existing Pin Attribute** name if pads already contain their sub net attributes.

Once the Sub Net has been created, you are returned to the **Sub Nets** dialog with the new sub net shown in the **Attribute Name** list:

Attribute Name	Match Value	Connect In Pin Order	Use Own Colour	Colour	Display Connection	Track Length Rule			
						Attribute	Match	Minimum	Maximum
HS1	*	☐	☐		☐	<Sub Net Name>	HS1	6.35000	12.70000
Pin_Order	*	☑	☑		☑	<Sub Net Name>	Pin_Order	19.05000	27.94000



Once a sub net has been created that contains a list of ordered pads, you can use the **Add** and **Remove** buttons or **Edit Values** to adjust the sequence and make edits.

Add will allow you to pick multiple pins from any net. **Remove** will only work if the pad has a local attribute value (can't remove a part attribute value).

The **Edit Value** button is used to change the value on the attribute, for setting or changing a pin order for example. You will get an error if the value provided does not match the sub net attribute match string.

Creating template sub net names with no attributes

When creating sub nets there is a radio button in the **Create Sub Nets** dialog called **Just Add Sub net Entry**. Choosing this will hide the selection lists and create a new sub net row in the grid each time the **Add Sub Net To List** button is pressed. This allows you to create sub nets and pin attribute names, but assign the attributes to the pins at a later stage.

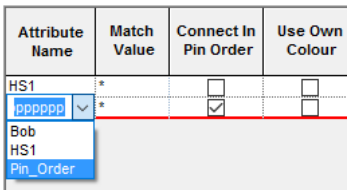
If creating sub nets in a Technology file there are no pins, so pressing the **New** button directly adds a blank sub net to the Technology page.

Renaming Sub Net Attribute Names

When renaming sub net attribute names, it should be noted that if the attribute name has already been defined for a sub net, that attribute name will still reside on the pin and will not be renamed. Effectively, you are creating a new Attribute name by renaming the existing one.

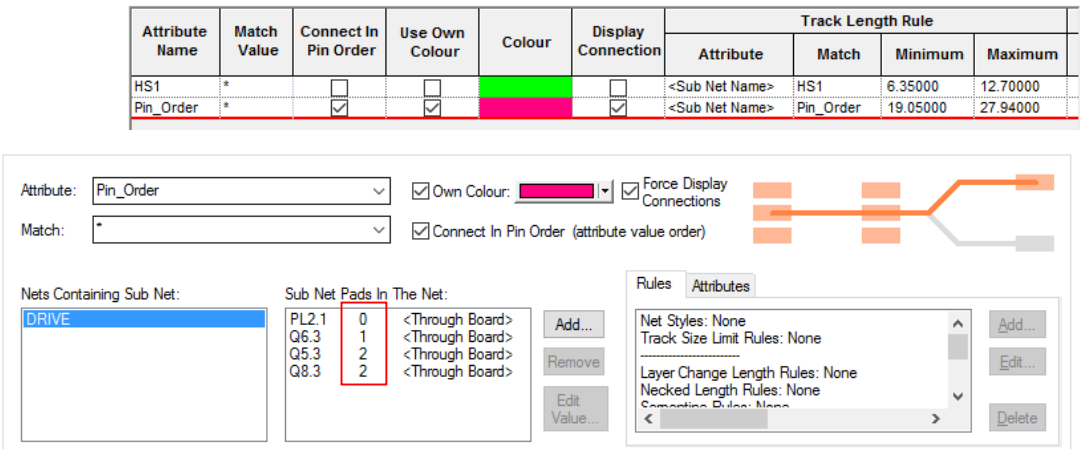
If you wish to change the attribute name, this must be done in the Attributes page of the Technology. Once the name has been changed, you will then need to select it using the Sub Nets dialog and Attribute Name.

In the example below, the attribute name pppppp has been renamed to Pin_Order. In order to use this new name, Pin_Order must be selected from the drop down list.



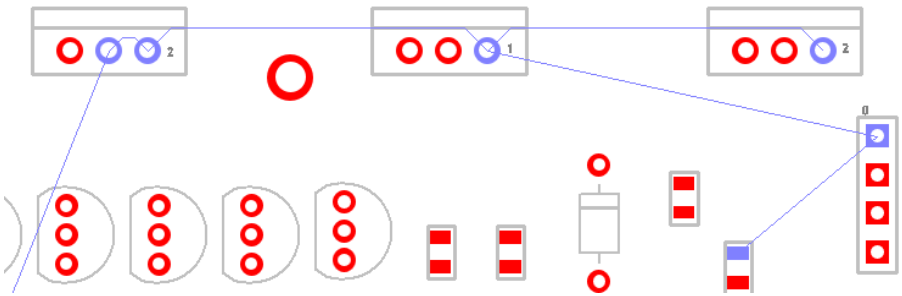
Connect In Pin Order

Choosing the **Connect In Pin Order** button on this dialog will allow you to define the daisy chain order for the routing sequence in your design. This is defined by the numerical value on the pin and is displayed in the **Sub Net Pads In The Net** box.



Attribute Name	Match Value	Connect In Pin Order	Use Own Colour	Colour	Display Connection	Track Length Rule			
						Attribute	Match	Minimum	Maximum
HS1	*	☐	☐		☐	<Sub Net Name>	HS1	6.35000	12.70000
Pin_Order	*	☑	☑		☑	<Sub Net Name>	Pin_Order	19.05000	27.94000

The resultant design will connect in this specific order and **Optimise Nets** will also adhere to this order:



Existing Pulsonix V8.5 Designs

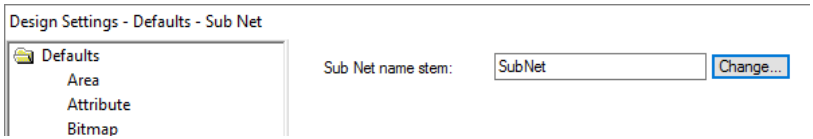
If you have already used **pin attributes** to define sub nets in a previous version of Pulsonix, i.e. V8.5 or older, then these would now be converted into sub nets.

New Designs

If starting a new design in V9.0, you could use Sub Nets to define specific Daisy Chain orders on a net.

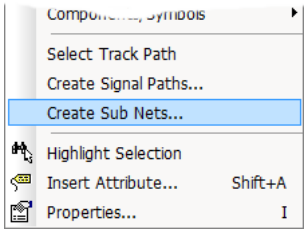
Designs Settings and Default Sub Net names

Default Sub Net names can be predefined using the **Sub Net** entry on the **Design Settings** dialog. When used, the name is incremented each time it is used. You can edit and rename this name if required.



Interactively Creating Sub Nets

In select mode, you can select multiple Component pads and Pad branches and use the context menu option **Create Sub Nets** to create sub nets containing those pins.

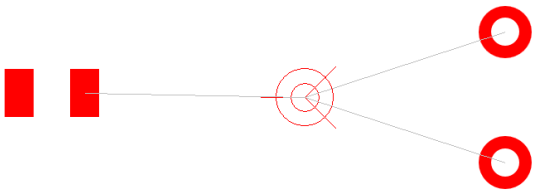


Once selected, the **Create Sub Net** dialog is available with the sub net preselected from where you can add this sub net entry to the **Sub Net** rules within the **Technology**.

Branch Points Overview

Branch points enable intelligent splitting of nets. They are named items in the form of auto-generated doc symbols or user-defined doc symbols or vias (in PCB).

They can added to a net in a Schematic to indicate a point where the track in the PCB is to split to branch to two or more target pads. Alternatively they can be added to sections of a Net(s) for when you wish to create specific rules for given track segments e.g. fattening a track segment.

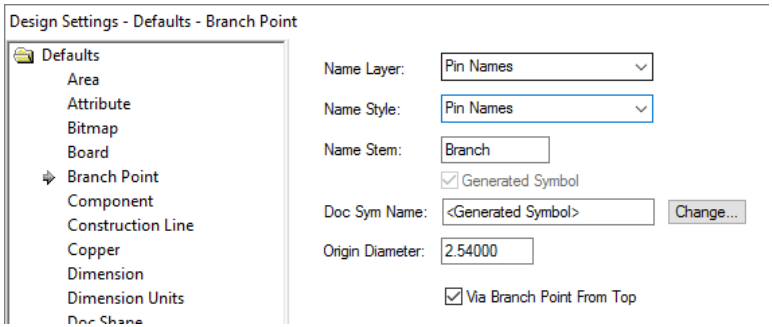


When added to a Schematic design they are automatically transferred to the PCB. Once added they can be used on **Signal Paths, Sub Nets** and **Differential Pairs**.

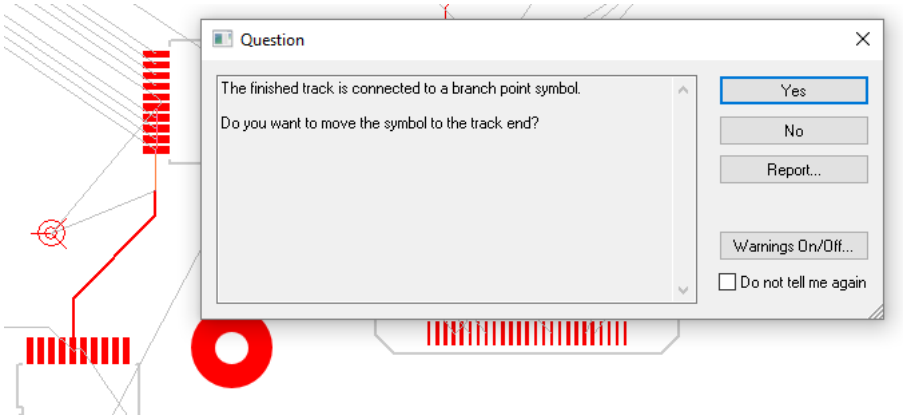
Branch points are added to the design using the **Add Branch Point** option or by using **Change Branch Point** on a selected **via**. When added, you are required to attach the branch point to a pad or connection.

Branch Points do not require a doc symbol for addition, you can specify that they are to be **Auto-Generated**, in which instance Pulsonix will add its own basic symbol suitable for use. The default branch point origin is shown as a target with three lines to make it stand out in a design.

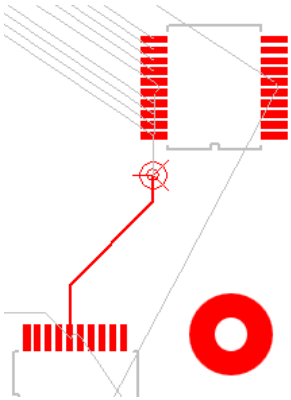
The default symbol or auto-Generated symbol is specified in the **Design Settings** dialog and **Branch Point** page. You might use your own **Branch Point Doc Symbol** to add extra detail for plotting or some other highlighting. When branch points are used in the design they are zero size items and are purely used for electrical connectivity purposes.



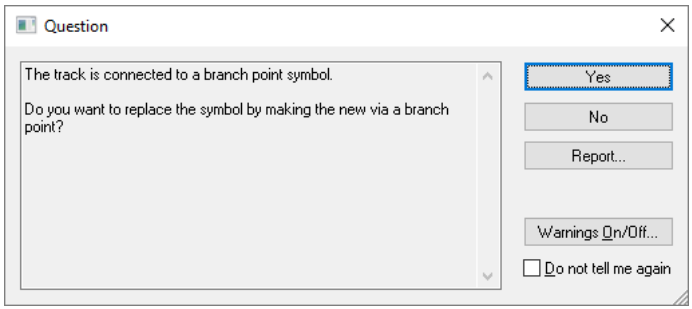
When adding a track (or a differential paired track) with a connection attached to the end that ends on a branch point, after finishing the track at a set position you will be asked if you want to move the branch point to the end of the track:



If **yes** is pressed, the branch point is then moved to the end of the track:



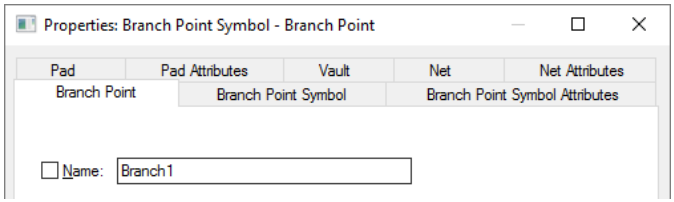
If the track ends on a via then you will be asked if you want to change the via to a branch point via, replacing the doc symbol branch point.



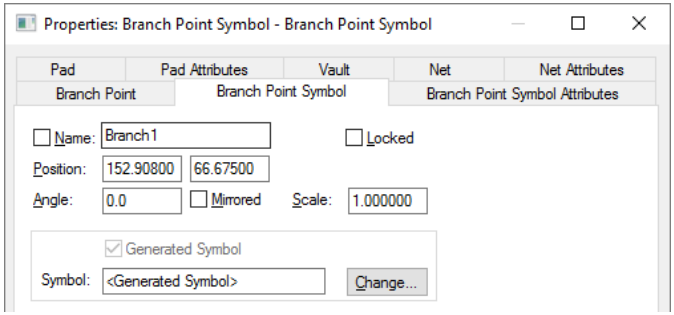
Branch Point Properties

A branch point doc symbol or via has two new tabs in Properties to show the **Branch Point** name and **Branch Point Symbol** information.

The **Branch Point** tab allows you to display and change the name of the branch point.



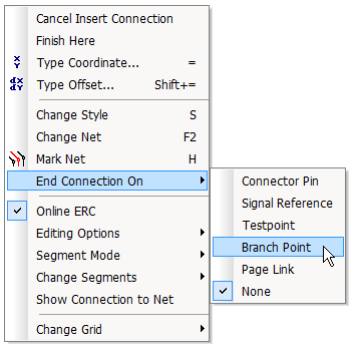
The **Branch Point Symbol** tab displays information about the position of the branch point and the symbol used.



For **auto-generated** branch points, the **Properties** dialog will display a **Symbol** name of **<Generated Symbol>** with the option to change it for one of your own from the library.

Branch Points – Additional Fetaures

In schematic you can start and end a connection directly on a new branch point from the context menu using the **Start/End Connection On** option.



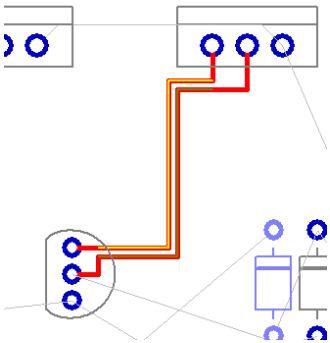
You can **cross probe** branch points between Schematic and PCB, and vice-versa.

You can use **Auto Rename** and **interactive rename** tool on branch points.

Differential Pair Routing

Overview of Differential Pairs

Differential Pairs and **Differential Pair Chains** can be specifically defined at both Schematic and PCB stages. Functionality within Pulsonix allows parameters to be created so that **Differential Pairs** behave and are routed as required. The interactive Differential Pair Routing feature is available in the PCB design editor.



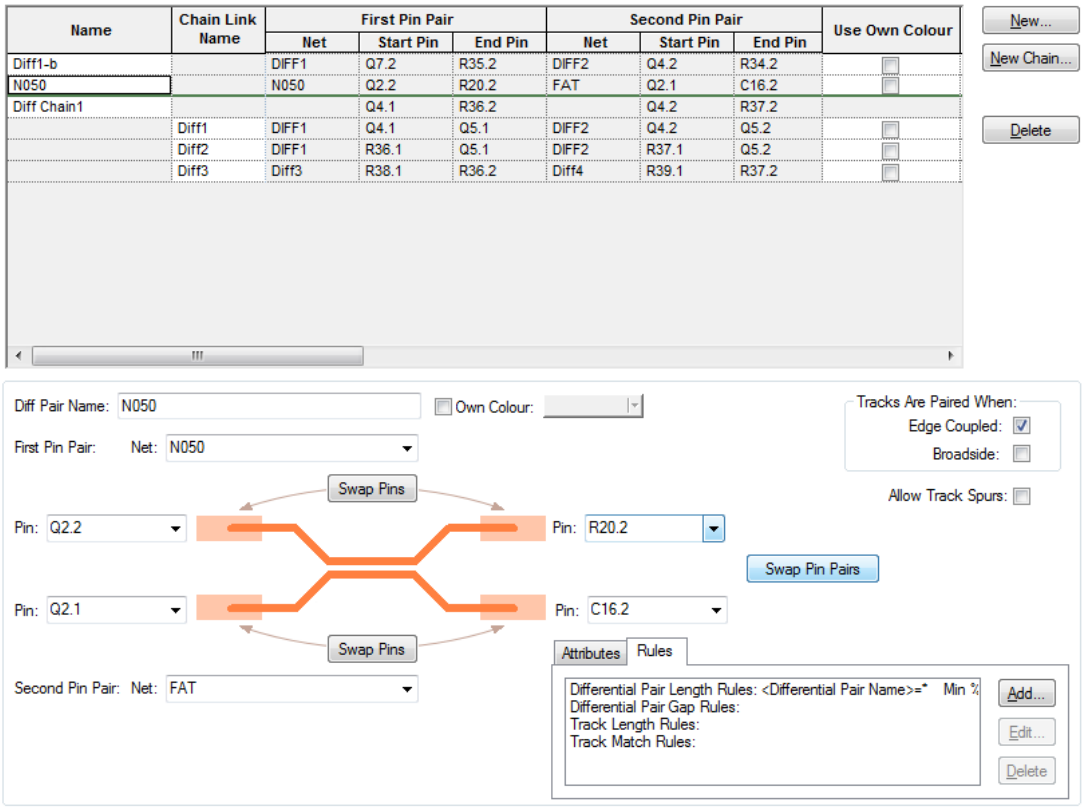
Differential Pairs are defined in Pulsonix using the **Technology** dialog and **Differential Pairs**. Rules can be defined for them, such as how close the tracks should be and how much they are allowed to differ in length as two rule examples. Other rules may be applied to Differential Pairs, such as the default Minimum Gap and Minimum Layered Gap. Rules from other high speed options can also be used, such as overall Track Length of the net and Serpentine Routing.

Once the rules are defined, a special manual routing mode for differential Pairs can be used to route the two track pairs at the same time. Paired track sections are locked together using the rules gap defined in the Differential Pairs dialog. Whilst paired, subsequent editing of the tracks will keep them locked together using the functionality provided.

Defining Differential Pairs

A Differential Pair requires two pairs of pins on two different nets. There are two methods for selecting the nets; you can preselect the two nets by firstly selecting each paired connection in the design (select the first then use <Ctrl-pick> to select the second one). Once in the **Technology** dialog and **Nets, Differential Pairs**, pressing the **New** button will automatically add these two nets as the new 'pair'.

The second method is to use the **Differential Pairs** dialog to select both nets using **First Pin Pair** and **Second Pin Pair** drop down boxes. The drop down list selection allows picking nets and pins on that net within the design. The first method of preselecting the nets is much easier though.



Differential pairs can have a unique name to help identify them. The default name will be constructed from the four pin names, but can be changed to a name of your own choice.

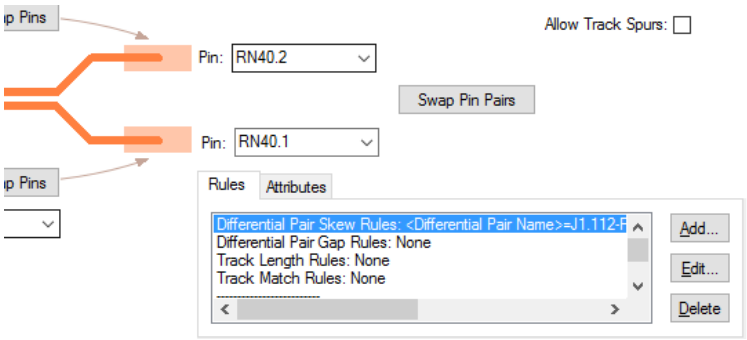
As well as Differential Pairs, you can also defined Differential Pair Chains, these are discussed in more detail later on in the section.

Choose the type of Differential Pair that the pairs are allowed to use; **Edge Coupled** (side-by-side) or **Broadside** (one on top of the other on different layers).

Allow Track Spurs – Normally, the path between the pins in a differential pair should be without any spurs or branches to other pads, vias, etc. Checking the **Allow Track Spurs** option will allow spurs from the track path. These spurs must not have any further spurs or branches and should be terminated on a pad, via or testpoint. These will be checked as part of the Differential Pair Design Rule Check and in the Differential Pair report.

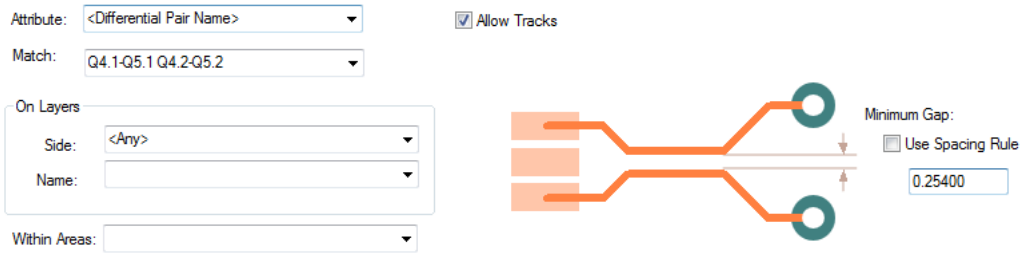
Differential Pair Attributes

Differential pairs can have attributes assigned to them for specifying which rules they use. The rules can be added using the **Add** button on the **Differential Pair Rules** dialog or by creating the rule to be assigned on the relevant **Rules** page.



Differential Pair Gap

Once the Differential Pair has been created, you may create the gaps that the pair will use. These are defined in the **Technology** under the **Differential Pair Gaps** page.



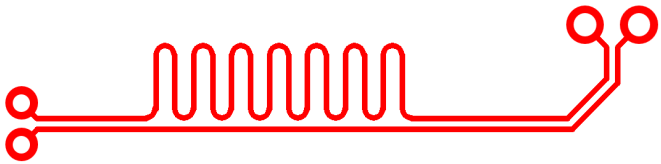
The gaps can be defined for layers or areas if required. Wildcards are allowed, for example Layer = Inner*

Allow Tracks - Use the **Allow Tracks** in conjunction with **Layers** and/or **Area** to create a rule that allows or disallows tracks on that layer or area. You could, for example, disallow differential pairs on Inner layers. This dialog allows you to create a rule for it.

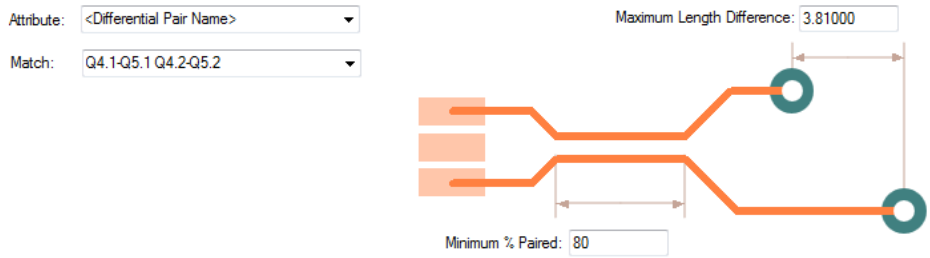
Minimum Gap - The Minimum Gap is the distance used when a differential pair is considered paired (i.e. it runs parallel). You can choose to use the **Use the Spacing Rules** to derive the gap, or specify a minimum gap. Note that the gap specified here can be smaller than that derived from the spacing rules.

Differential Pair Skew

The **Differential Pair Skew** page is used to define the **Minimum Percentage** pairing of tracks. An additional new rule defines the **Maximum Length Difference** between the Differential Pair tracks. This defines the 'skew' between the two tracks in the pair.



This feature allows you to add skew to one track of the **Differential Pair**.



Pair to Pair Match Lengths

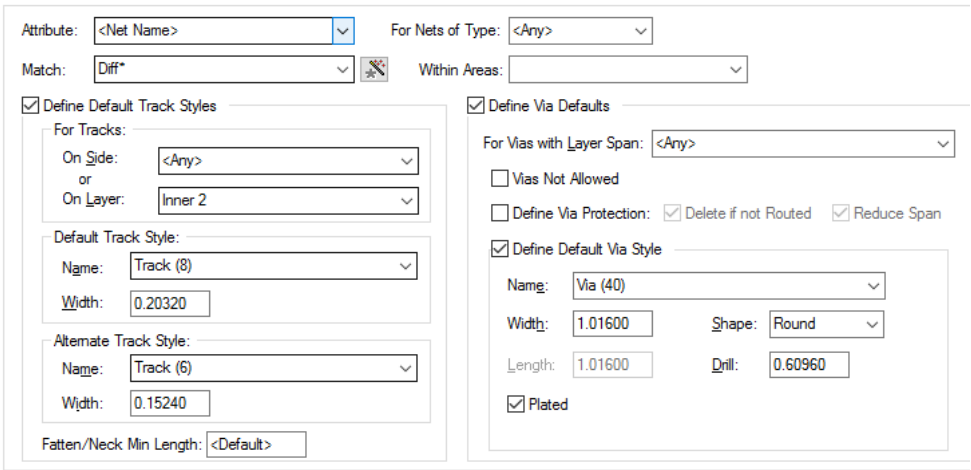
If you need to match a pair of Differential Paired tracks against another set or sets, then you can use the **Track Length Match Rule**. This allows you to define multiple Differential Pairs against each other.

Attribute Name	Match Value	Extra Delay Length	Max Length Difference
<Net Name>	Diff*	0.00000	3.81000
<Net Name>	HS	0.00000	12.70000
<Net Name>	HSE	0.00000	2.00000
<Net Class Name>	PAIR	0.00000	6.35000

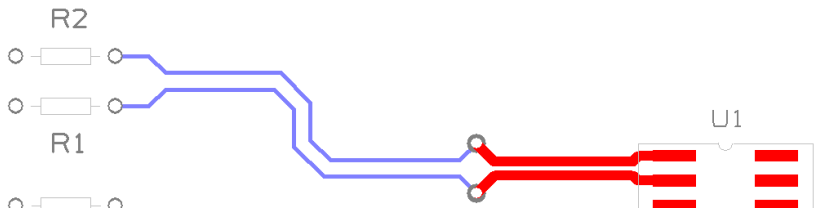
Defining Differential Pair Track Styles

As with other nets, Differential Pair track thicknesses and Via sizes are defined in the **Net Styles** dialog.

Attribute Name	Match Value	Net Type	Area	Track Styles					Via Styles		
				Track Side	Track Layer	Def. Track	Alt. Track	Fat/Neck Min Len	Via Span	Via Style	V Prot
<Net Name>	Diff*				Inner 2	Track (8)	Track (6)	<Default>		Via (40)	
<Net Name>	Diff*			Inner		Track (8)	Track (10)	<Default>			
<Net Class Name>	Diff					Track (10)	Track (8)	<Default>		Via (40)	
<Net Class Name>	GND					Track (55)	Track (25)	<Default>		PadStyle1	
<Net Class Name>	GND2					Track (55)	Track (25)	<Default>		PadStyle1	
<Net Class Name>	HS					Track (10)	Track (15)	2.54000		Via (40)	
<Net Class Name>	HS3					Track (55)	Track (25)	<Default>		PadStyle1	
<Net Class Name>	Power					Power (50)	Power (25)	<Default>		Via (50)	
<Net Class Name>	Sig2					Signal (8)	Signal (6)	<Default>		Via (40)	

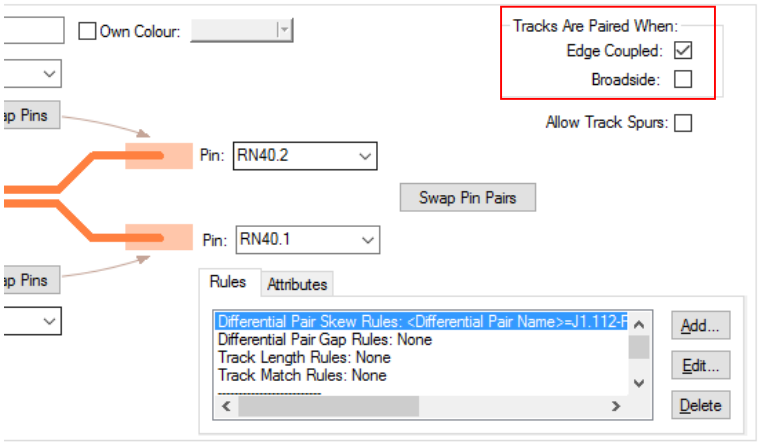


As well as defining the Track and Via styles to be used, you can also define how the Differential Pair track style will behave on other layers or within areas. This is normal track and via style definition but also equally applies to Differential Pairs where this is critical.



Using Edge Coupled or Broadside Differential Pairs

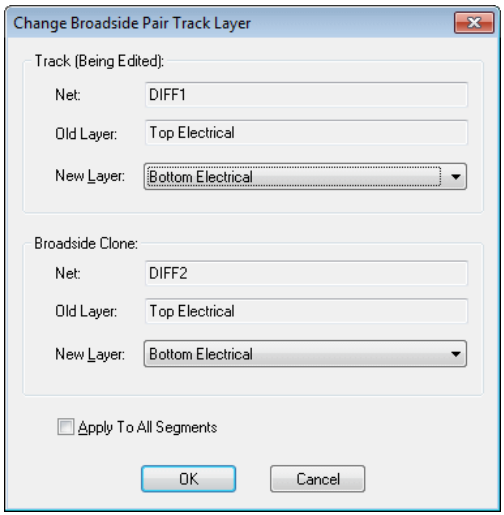
You can define how the Differential Pair tracks are ‘paired’. **Edge Coupled** are the usual Differential Pairs, the edges of the two tracks separated by the specified gap and appear on the same layer side-by-side. **Broadside** Differential Pairs are paired vertically, the tracks laid on top of each other on different layers. It is possible to allow both types of pairing on a differential pair. The choice of which type to use will depend on your design and the technology being used. Usually you would use one or the other method, but Pulsonix also allows mixing the track pairing methods.



For **Broadside** only coupling, the gap can still be provided and will be used for the minimum separation of the tracks when they are on the same layer, for example when routing out of surface mounted pads but this will not contribute to the % paired.

Adding Broadside Differential Pair Tracks

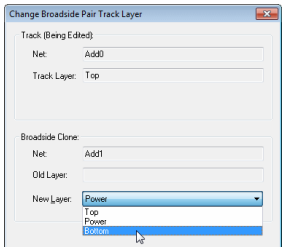
When adding a Broadside Differential Pair track, using **Start Differential Pairing** will prompt for the **Broadside Clone Layer**. This is the layer that the 'copy' of the track being added will go on.



When using **Start Mirroring Paired Track** if both tracks are attached to surface mounted pads, mirrored tracks will be added, but you will not be able to start pairing yet and the defined gap will be maintained. If you start mirroring from through-hole pads or vias, you will be asked for the layer for the clone and the mirrored track will change to that layer. The mirrored tracks will be allowed to come together and when this happens a click will start broadside pairing, one track on top of the other.

Changing Layers of Broadside Differential Pairs

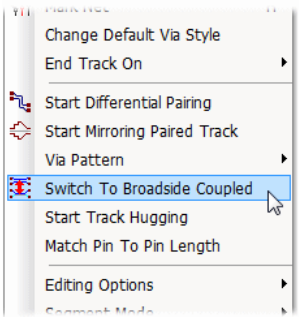
While using Broadside Differential Pairs, you can change the layer for both the track being edited and its broadside clone at the same time.



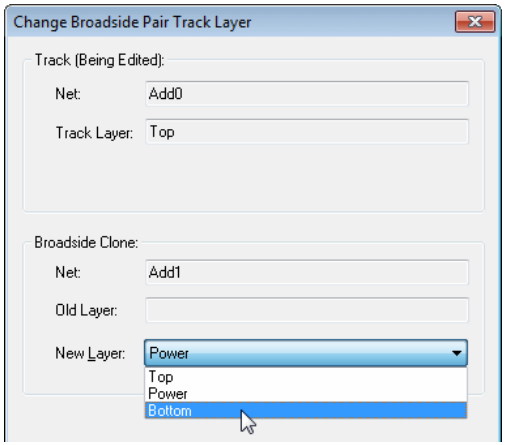
Note: This dialog is sometimes displayed when you can only change the clone layer, for example when starting differential pairing on a broadside diff pair.

Switching between Differential Pair types

When adding differential pair tracks that allow both coupling types, you can switch between them using **Switch To Broadside Coupling** or **Switch to Edge Coupling** from the context menu.



This can only be done when not actually adding paired tracks, so you have to un-pair, change coupling type and re-pair again. When switching to Broadside coupling you will again be asked for the layer for the broadside clone track.



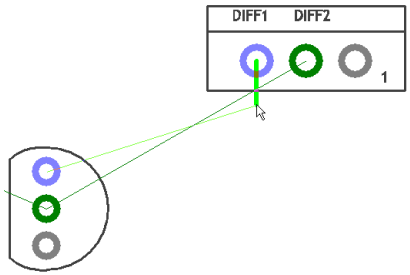
For Broadside coupling the paired length will be calculated where one track is completely over the other, but if both edge and broadside coupling is allowed, both types of paired sections will be added together to give the total figure.

Routing a Differential Pair

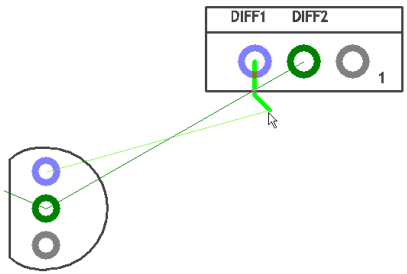
This is how you route Differential Pair tracks:

▶ To route a differential pair

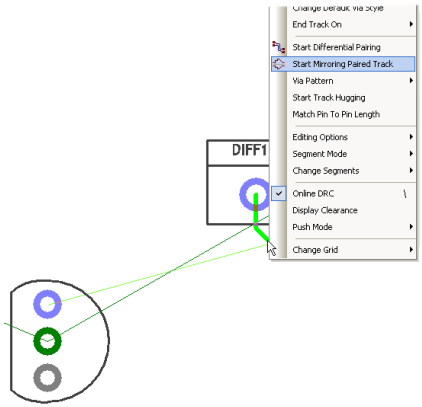
1. There are a number of ways to create differential pairs. We will use the more straight forward method to start with.
2. You would have set up your **Differential Pairs** already using the **Technology** dialog.
3. Begin to start routing from one of the pins in the set (double click on the net). Don't add any corners, the Start Mirror Paired Tracks option only works from the initial track segment off the source pad.



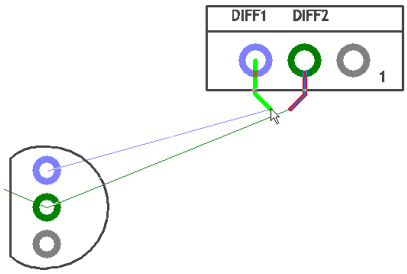
4. In this example, we will move the cursor inwards to create a 45 degree mitre as well. The routing mode is already enabled in **Angled (45)** mode (from the **Options** dialog and **Edit Tracks** page).



5. Right click the mouse and from the context menu, select **Start Mirroring Paired Tracks**.

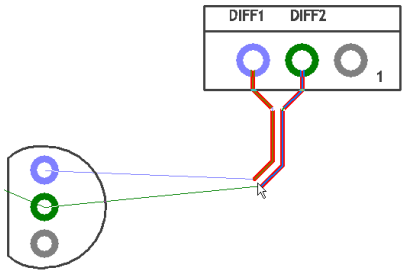


6. This will create the initial paired tracks using a mirror image of the first track you routed to start with.

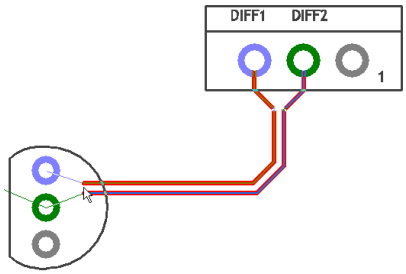


7. Moving the cursor closer to the paired track will now bring the tracks together using the **Track to Track** spacing rule defined in the **Technology** (or any additional **Net Class** or **Net Styles** rules or **exception rules** added to the net).

8. Move the mouse closer to the second track and click to add the first corner, it will not move closer than the **Spacing Gap** defined.

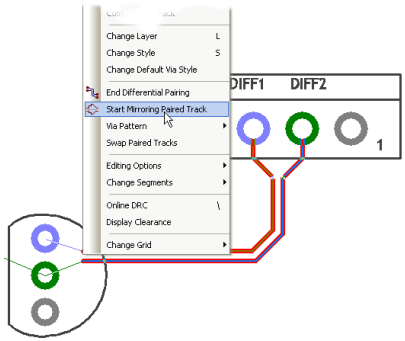


9. Move the cursor towards your end target, click once to add corners just like regular track editing. Changing layers will be demonstrated a bit further on.

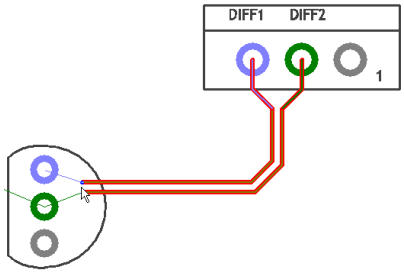


10. Position the cursor mid-way between the target pads.

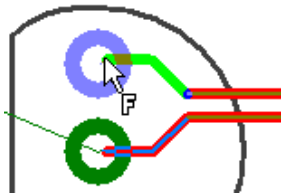
11. Right click the mouse and from the context menu select **Start Mirroring Paired Tracks** again.



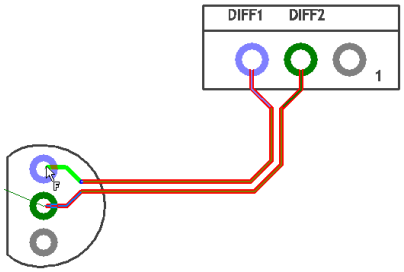
12. This will instruct this option that you wish to now finish the track pairing in a defined way.



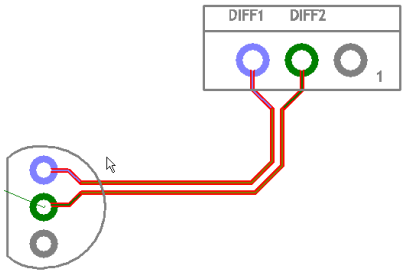
13. Assuming you are still using the **45 Degree Segment Mode**, moving the one track towards the target the other track will ‘mirror’ this image.



14. With the cursor now over the target, the **Finish** marker will be shown.



15. Click to finish.

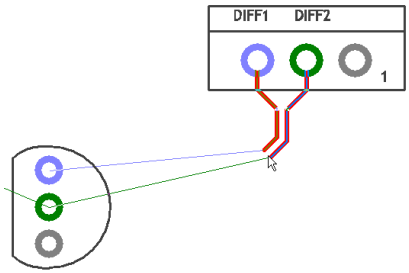


16. The completed result looks like the above example.
17. These two tracks will now behave as a differential pair and will use the rules provided. **Design Rules Check** etc. will also know about these tracked pairs.

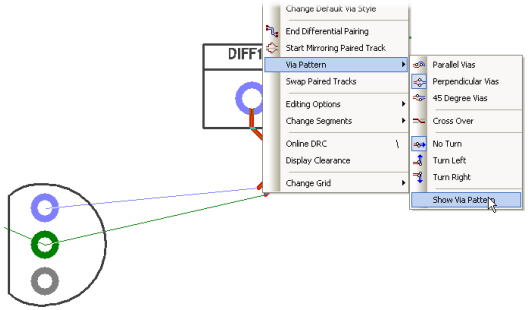
Changing Differential Pair Layers

▶ To change layer during differential pairing

1. During differential pairing you may wish to change layers.
2. To do this, right click and select **Change Layer** from the menu or the shortcut <**L**>. as normal
3. Because you are already in Differential Pairing mode, you can opt to show the position of the vias and the next track segments.
4. Once your routing has been started (using **Start** or **Mirror Differential Pairs**), right click.

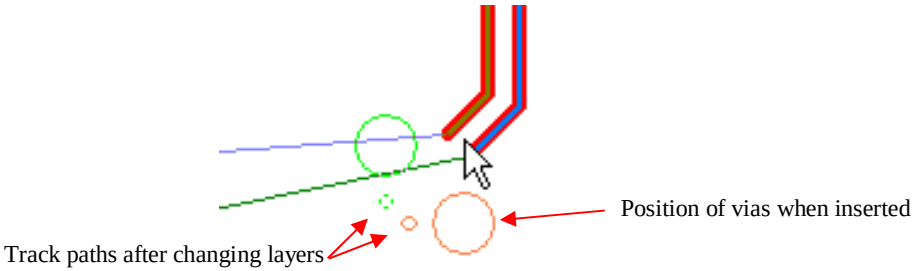


5. To show the vias, select the **Via Pattern>** option from the context menu.



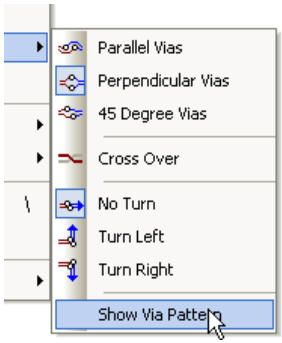
6. At the bottom of the sub-menu, select **Show Via Pattern**.
7. Now when you route, the via pattern and track positions will be shown. These will move dynamically with the routing to show their position if used.

8. These are shown as outline shapes for clarification. The larger circles will indicate the Via position, the smaller circles indicate the next start position of the tracks on the other layer.



9. The via and track positions will depend on the via and track grids and the **Spacing Rules** defined in the **Technology**.

10. Also from the context menu, you can select the type of via pattern to be generated during a layer change.

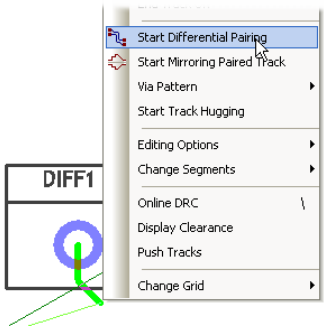


11. The patterns will be applied to subsequent routing after selecting from this menu so it is possible to use multiple-pattern types if required.

Alternative method for starting Differential Pair Routing

▶ Alternative method of starting differential pair routing

1. An alternative method to create differential pairs is to start the routing, then from the context menu, select **Start Differential Pairing**.



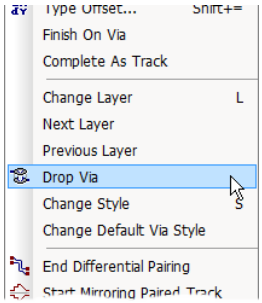
2. Any routing in this current session you add now will be paired.
3. Use the **End Differential Pairing** mode form the context menu to exit this mode.

Differential Pair Routing Functionality

Drop Via

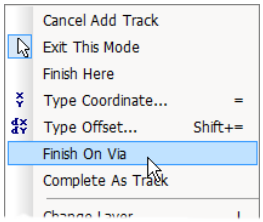
When adding a PCB track (or differential paired track), there is a new option on the context menu to **Drop Via**. This operates the same as **Change Layer;** adding a via at the end of the track but for this option, not changing the layer of the new track. A via is added along the track as you edit, thus enabling the continuation of the track after the via is dropped.

This is also available when adding differential pairs where it adds two vias with the appropriate track patterns to them, but not changing layer. This is useful when using DDR2 or DDR3 flyby routing to drop a via pair near each target pad pair, ready to be routed later.



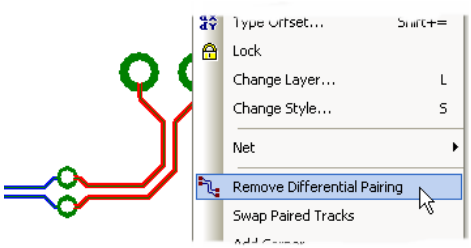
Finish On Via

The **Finish On Via** option is available when adding differential paired tracks. Use it to finish a paired section on vias, you may need to do this if creating a branch point for multiple-connected differential pairs. It was always available when adding a single PCB track, but is also available when adding differential paired tracks.



Removing Differential Pair Routing

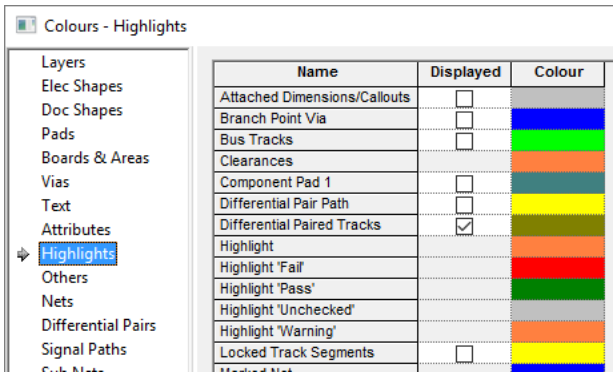
A paired section of track (or a selected part of it) can be unpaired using the context menu command **Remove Differential Pairing** whilst in select or edit modes on the selected track.



You can create any number of paired sections of track along the path but you must complete the gaps manually.

Defining Differential Pair Colours

You can draw **Differential Paired Tracks** in s different colour using the **Colours** dialog and **Highlights** page. These are in addition to the normal **Track** and **Net** colours which can also apply to Differential Pairs.

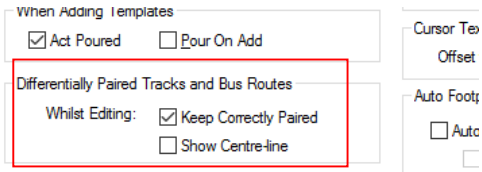


Differential Paired Tracks defines the colour of paired tracks in a Differential Pair.

Differential Pair Path defines the colour of the pad to pad path of tracks and connections in a Differential Pair. An individual Differential Pair colour can be defined from within the **Technology** dialog and **Differential Pairs** page.

Differential Pair Routing Options

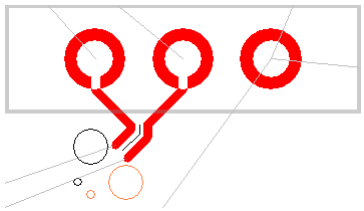
Check boxes are available on the **Options** dialog and **Interaction** page are available for **Differentially Paired Tracks and Bus Routes**:



Keep Correctly Paired

When checked, the **Keep correctly Paired** option will not allow doubling-back and acute corners when adding or editing paired tracks. This avoids the tracks ending up curved or further apart than the required gap. Uncheck it to allow full movement (as in previous releases). It may be that allowing illegal pairing during an edit is the only was to get to the actual position required.

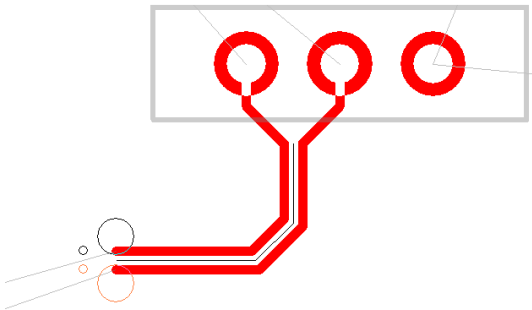
Without **Keep correctly Paired** checked. Tracks are allowed to be edited in illegally.



With **Keep correctly Paired** checked. Tracks are restrained to not allow an illegal path.

Show Centre-line

When checked, the **Show Centre-line** option is used to show the line between the paired tracks that you are actually editing. The centre line is the grid position that the differential paired tracks are following. This visual indication helps ensure the tracks are in the correct position and shows the selected dynamic segments.

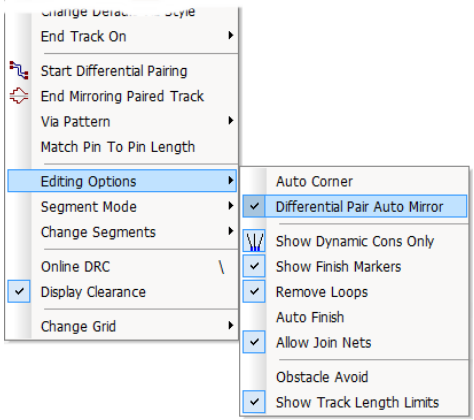


The line is removed as soon as the edit, move or move corner is complete on the differential pairs.

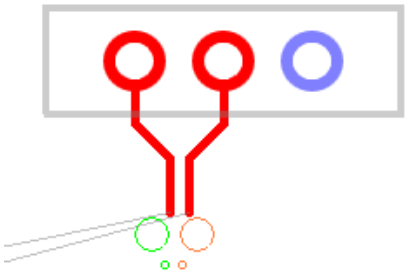
Automatically starting Diff Pairs as Mirrored

You can define if a Differential Pair is mirrored by default when the pair routing is started.

The option is on the context menu when in Insert Track for a Differential Pair. It is also available in the options sub menu on the context menu when editing the track.



With the option enabled, when you then start routing, the differential pair will be immediately mirrored.

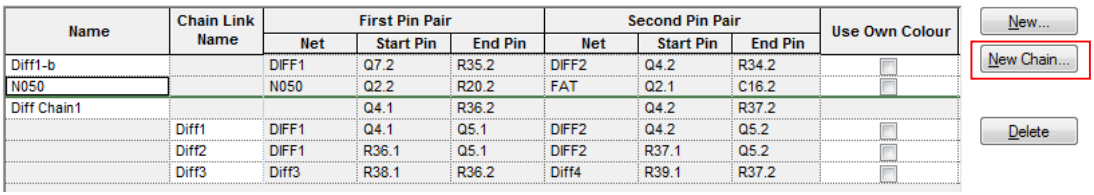


Differential Pair Chains

Why Diff Pair Chains?

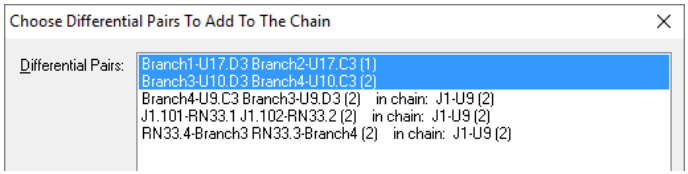
Differential Pairs can also be placed into ‘chains’ to create extended net paths without the nets requiring the same net name. A Differential Pair may, for example, terminate on a resistor but require the overall length of the tracks to include the other side of the net. Differential Pair Chains can be more than two pairs of Differential Pairs if required.

From the **Differential Pairs** dialog you can use the **New Chain** button to define a **Differential Pair Chain**. If your design only contains one pair of defined differential pairs, then selecting this button will display a warning that more than one pair is required.



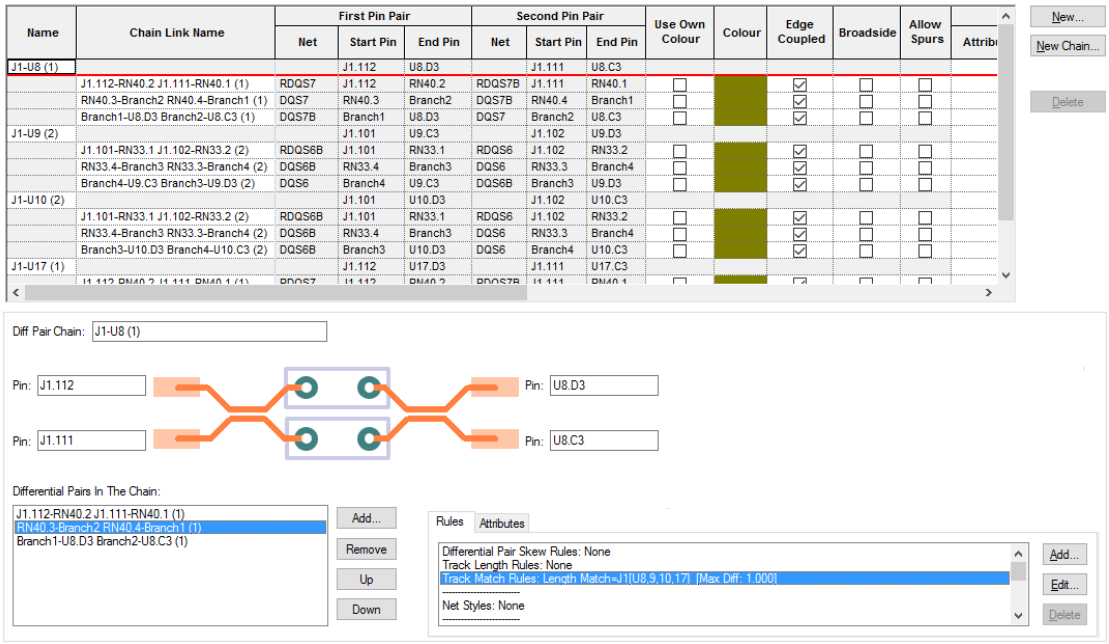
Name	Chain Link Name	First Pin Pair			Second Pin Pair			Use Own Colour
		Net	Start Pin	End Pin	Net	Start Pin	End Pin	
Diff1-b		DIFF1	Q7.2	R35.2	DIFF2	Q4.2	R34.2	
N050		N050	Q2.2	R20.2	FAT	Q2.1	C16.2	
Diff Chain1			Q4.1	R36.2		Q4.2	R37.2	
	Diff1	DIFF1	Q4.1	Q5.1	DIFF2	Q4.2	Q5.2	
	Diff2	DIFF1	R36.1	Q5.1	DIFF2	R37.1	Q5.2	
	Diff3	Diff3	R38.1	R36.2	Diff4	R39.1	R37.2	

The process is to choose a Differential Pair to make a chain from, then add additional Differential Pairs to create a chain. After pressing the **New Chain** button, the **Choose Differential Pairs** dialog is displayed:



From this, choose the pairs of pins to add to the chain, this can consist of more than two pairs. Drag the mouse to select more than one or use the standard **Ctrl** or **Shift** keys to make multiple selections.

With a new Chain defined, the lower portion of the Differential Pairs dialog now changes to a **Chain** image to allow you to define the chain pair.



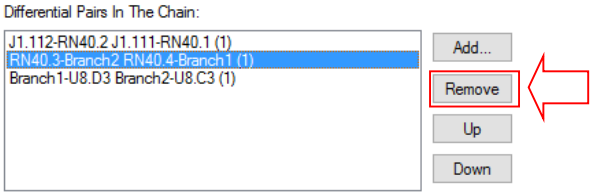
Selecting a Differential Pairs will toggle the image in this dialog between a standard Differential Pair and a Chain.

Additional buttons on this dialog allow you to manage selected Chains. Use the **Add** and **Remove** buttons to select more Differential Pairs to add to the chain or to remove exiting pairs. The **Up** and **Down** buttons allow you to change the order in which the Pairs appear in the chain. The chain name is derived from the first and last pair it finds in the list. It may also be that you add pairs to the chain out of sequence and these buttons allow you to re-sequence them. The order in the list is also used in the **Rules Spreadsheet**.

Deleting Differential Pair Chains

Differential Pair Chains cannot be deleted without first removing the **Differential Pairs** within them. This allows you to remove some pairs and not others from the chain.

Using the **Remove** button, each of the Differential Pairs must be removed.



Once this has been completed and there are no more Differential Pairs shown in the chain, the **Delete** button on the dialog is then available to delete the **Chain** name.

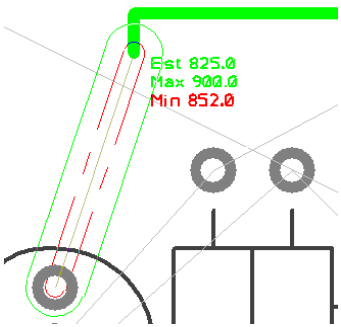
Name	Chain Link Name	First Pin Pair			Second Pin Pair			Use Own Colour	Colc
		Net	Start Pin	End Pin	Net	Start Pin	End Pin		
Branch1-U1		DQS7B	Branch1	U17.D3	DQS7	Branch2	U17.C3	☐	
Branch3-U1		DQS6B	Branch3	U10.D3	DQS6	Branch4	U10.C3	☐	
J1-U8 (1)			J1.112	U8.D3		J1.111	U8.C3		
	J1.112-RN40.2 J1.111-RN40.1 (1)	RDQS7	J1.112	RN40.2	RDQS7B	J1.111	RN40.1	☐	
	RN40.3-Branch2 RN40.4-Branch1 (1)	DQS7	RN40.3	Branch2	DQS7B	RN40.4	Branch1	☐	
	Branch1-U8.D3 Branch2-U8.C3 (1)	DQS7B	Branch1	U8.D3	DQS7	Branch2	U8.C3	☐	

New...
New Chain...
Delete

Length Based Rules

Interactive Net Length Indicators

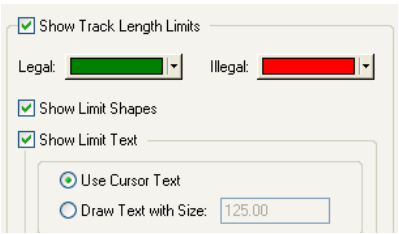
The interactive net length indicators allow you to display length rules in the PCB Design. The rules can be defined in the Schematic and passed through to the PCB during the translate stage. In the PCB design interactive track editing displays the rules as restriction boundaries and a head-up display.



Options to Display Track Length Indicators

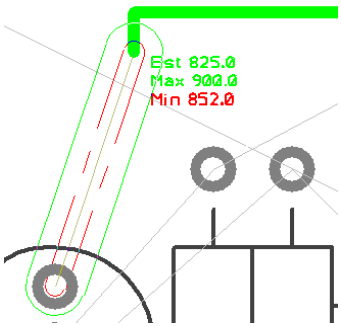
Options for displaying Net Length Rules

The colours for the **Legal** and **Illegal** track lengths can be defined in the **Options** dialog under **Track Length Limits**. Using **Show Limit Shapes**, the display of the length indicators can also be switched on and off.



Track Length Limit Shapes

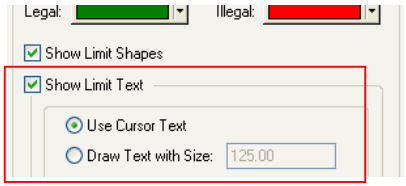
The Min and Max values can be displayed as numerical figures but also shapes. Coloured shapes indicate the extents of the limits.

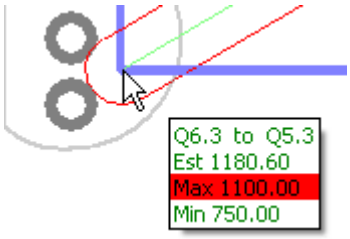


In the illustration above, the red box 'inside' the green box indicates that the minimum length has not yet been met, the green box indicates the extents to which the track must be routed to meet this. Once the min limit has been met, the red box then changes to be outside of the green shape to indicate the outer max limit of the track. These shapes change dynamically as the track us routed.

Track Length Limit Text (head-up display)

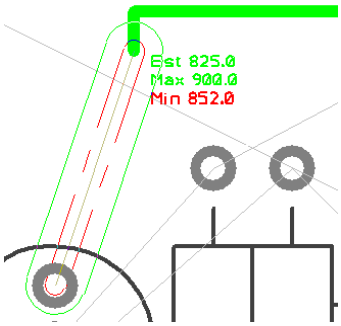
As well as the visual indicators for legal and illegal values, the actual rule values used can also be displayed using the **Show Limit Text** check box.



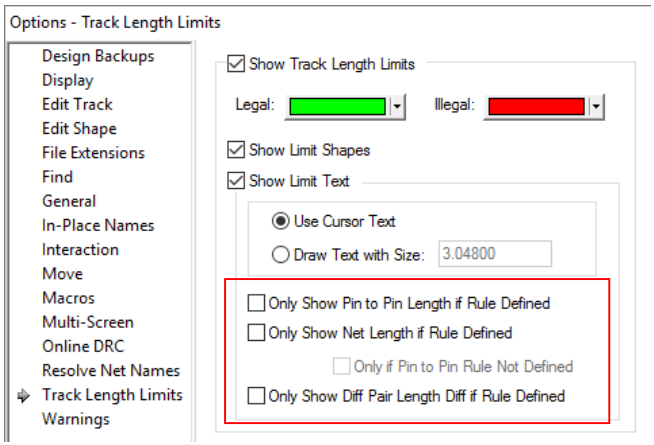


The **Use Cursor Text** option displays the limit text similar to a tooltip always on top of your design keeping it more legible especially in dense areas of the design. You can alter the distance the text box is from the cursor using the **Options** dialog and **Track Length Limits** page. You can also use the **Reposition Cursor Text** command whilst cursor text is being displayed to change its position relative to the cursor.

The **Draw Text** option simply draws the limit text in the design window. You can specify the height of this text in the current design units. This is the actual height on the screen and is not related to the current drawing scale of the design.



‘Only Show’ Rules



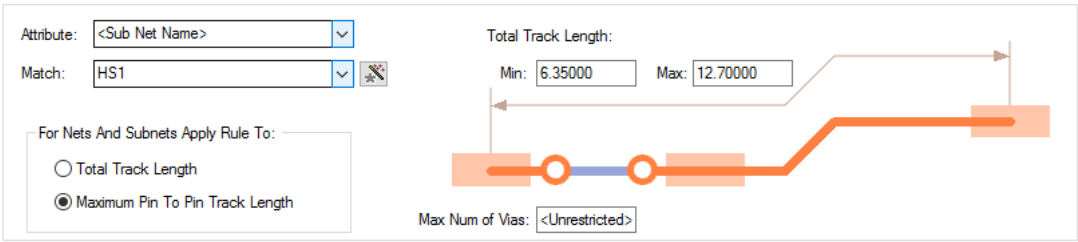
Use the three **Only Show...** text boxes to decide if you always want to show the appropriate length, or only show the text if there is a maximum or minimum length limit rule defined. If you are only showing the net length if there is a rule defined, you also choose if you want to display this as well as the pin to pin length or only if the pin to pin length is not displayed.

The Pin to Pin length is the sum of all tracks and unrouted connections in the path between the pins. All unrouted connections have their length estimated assuming they will be routed using the angled segment mode, except the connection at the end of the track being added that might instead use the orthogonal length or direct connection length depending on the current segment mode.

Track Length Rule

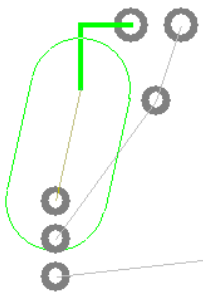
The **Track Length Rules** page enables you to control the length limits of the overall track length and the pin to pin lengths required. You can define **Min** and **Max Track Lengths which** can be applied to any Net-based items and as Attributes to the items. Within this rule there is a sub-category to define separate rules the **For Nets And Sub Nets Apply Rule To:** can be selected for the **Total Track Length** or for the **Maximum Pin To Pin Track Length**. You can have the same rule contain both of these sub-categories but they must be defined twice, once for each rule.

Attribute Name	Match Value	Total Track Length		Max Vias	For Nets and Subnets Apply Rule To	
		Minimum	Maximum		Total Track Length	Pin To Pin Track Length
<Differential Pair Name>	Diff	33.02000	44.45000	2	☐	☑
Track_Length	HS	5.08000	81.28000	2	☑	☐
<Net Class Name>	HS1	63.50000	76.20000	<Unrestricted>	☑	☐
<Net Class Name>	HSE	8.00000	14.00000	1	☐	☑
<Net Class Name>	PAIR	38.10000	45.72000	<Unrestricted>	☑	☐
<Net Class Name>	Sig2	19.05000	27.94000	2	☐	☑
<Net Class Name>	Signal	2.54000	17.78000	<Unrestricted>	☑	☐
<Sub Net Name>	HS1	6.35000	12.70000	<Unrestricted>	☐	☑
<Sub Net Name>	Pin_Order	19.05000	27.94000	2	☐	☑

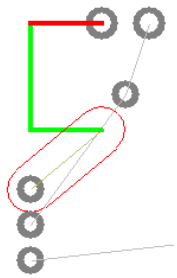


When the **Track Length rule** has been defined for a **Net item** or **net attribute,** during editing, a coloured graphical shape is displayed indicating the track length limits based on the rules defined.

Separate shapes are drawn to indicate minimum and maximum track length rules.

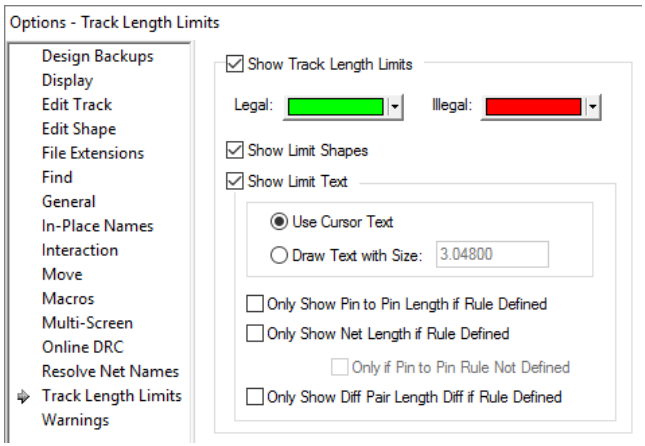


The large oval area shows the length of the track is within the minimum track length set.



The small oval area shows that the maximum length rule has been exceeded.

Parameters for defining the display of the length rules can be set in the **Options** dialog and **Track Length Limits** tab.



Show Track Length Limits

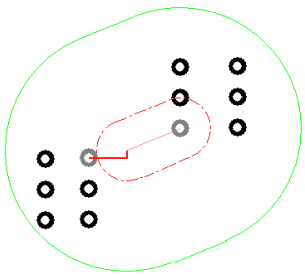
Check this option to show length limit shapes or text in general. Whilst using **Edit Track**, the length limits can also be turned on or off using the shortcut menu **Editing Options - Show Track Length Limits**.

The text and shapes are colour coded to show **Legal** and **Illegal** values. Green and Red are the defaults, but you can use any colours.

When you are within the maximum track length limits, the limit shape or text is drawn in the legal colour. When the maximum limit is exceeded, the shape or text is drawn in the illegal colour and the shape will grow as the excess increases. Minimum limits are always drawn in the illegal colour in a dashed style, until the minimum is exceeded, when the shape is not drawn.

Show Limit Shapes

Limit Shapes give you a visual indication of how far the track can extend and still be legal. You should be able to legally reach any point between the inner and outer shapes



Show Limit Text

The limit text gives information about the current estimated length and length limits that apply.

Use Cursor Text, uses the system defined tooltip font and text size. The text has a background box drawn in the current background colour.

Draw Text with Size, inbuilt font drawn at the given text size. The size is given in the current design units, but you can specify other units on input (e.g. 3mm). The text has no background so improves visibility of surrounding items at the expense of readability.

You can alter the distance the text box is from the cursor using the **Interaction Option - Cursor Text Offset From Cursor**. You can also use the **Reposition Cursor Text** command (available from the context menu - Editing Options), which shifts the cursor text into the next quadrant.

Pin to Pin Length

The Pin to Pin Length is the track length between the two *nearest* **Component Pins** or **Branch Point** by tracking a path from each end of the connection being edited. This length will follow through vias. The names of the two pins will be show along with the length.

You can choose to **Only Show Pin to Pin Length if a rule is Defined** which limits the length of the Pin to Pin connection.

Net Length

The Net Length is the total track length within the current net.

You can choose to **Only Show Net Length if a rule is Defined** which limits the length of the Net. More specifically, you can choose to Only Show Net Length **If a Pin to Pin Rule** is defined which limits the length of the connection.

Differential Pair Length

The length of a Differential Pair is the track length of the path between the start and end pins of the selected *side* of the pair.

You can choose to **Only Show Differential Pair Length if a rule is Defined** which limits the length of the Differential Pair.

Length Rules

You can define **Track Length Rules** (explicit length limits) and **Track Length Match Rules** (length Limits defined by comparing with other lengths) in the technology.

You can also define track length limits on a **Pin Network Part**.

You can also show pin to pin length limits without rules being defined in the technology by using the **Match Pin To Pin Length** option when editing tracks.

How Limits are Calculated

The connection you are editing may be part of a number of length limited items. The lengths and applied rules are evaluated for all of these, and the most limiting rules are found. The rule which most limits the minimum length may not be the same rule which most limits the maximum length. The two most limiting rules are the ones which are displayed. It could be possible that the minimum and maximum are such that it is impossible to satisfy both without making wider changes to the design.

How the Lengths are Calculated

The lengths are calculated by adding the lengths of all the tracks which make up the Total or Pin to Pin Length of the length limited item (as required for the rule being evaluated). Unrouted sections, or trailing segments are estimated using a 45 degree plus orthogonal projection. Length adjustments are also applied using **Track Length Factor Rules**, **Layer Change Length Rules** and **<Pin Package Length> Attribute** on a pad.

Track Length Match Rule – Sub Nets

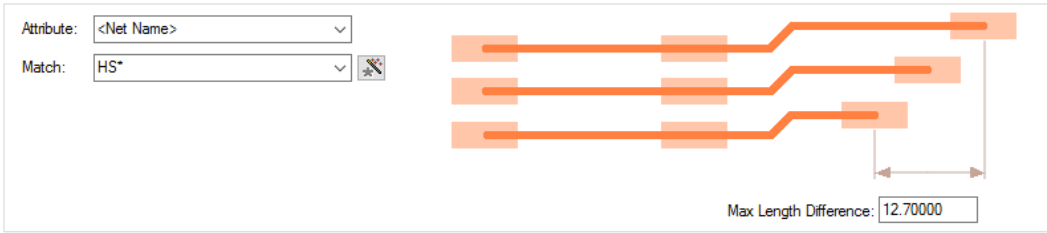
An additional option is available for the **Track Length Match Rule**. It is present when the <Sub Net Name> attribute has been selected from the drop down and displays an additional check box for **Only Match Sub Nets Within the Same Net**.

This allows you to say only match a sub net with other sub nets in the **same net**. You would select this if having copied an identical section of circuit that has sub nets within it. Leave it unchecked to match the length of all matching sub nets in any net.

Track Length Match Rule

The **Track Length Match** rule is used to define length differences between different nets. You could 'cluster' nets and associate them using an attribute name which can then be matched or you can use standard design items such as <Net Name>, <Diff Pair Name>, <Net Class>, <Signal Path Name> and <Sub Net Name>. You can also add a net attribute to provide a tag to add to any required nets.

Attribute Name	Match Value	Extra Delay Length	Max Length Difference
<Net Name>	Diff	0.00000	3.81000
<Net Name>	HS*	0.00000	12.70000
<Signal Path Name>	HSE	0.00000	2.00000
<Differential Pair Name>	DIFF*	0.00000	6.35000



The **Match Length Difference** value is the maximum length difference (or skew) between any item in the match group.

Use the **Extra Match** button to add an extra match group to the currently selected group, this adds a new line to the grid. The **Attribute Name** cell is blank because it is the same as the first line, but you must add a different **Match Value**.

Extra Match

The **Track Length Match Rule** also has ability to add **extra match** strings to it. Use the Extra Match button to create extra rows for the current Match rule. Using this, enables you to directly define a rule for two net names for example without having to use complicated match strings.

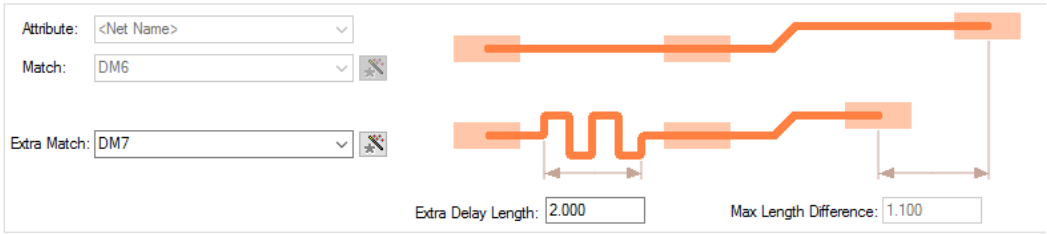
Attribute Name	Match Value	Extra Delay Length	Max Length Difference
Length Match	RDQ48-59	0.000	1.000
<Signal Path Name>	*Branch*	0.000	0.500
Length Match	J1[U8,9,10,17]	0.000	1.000
<Net Name>	DM6	0.000	0.000
	DM7	0.000	

When the **Extra Match** rule is set to zero, this means simply ensure that the explicit nets are matched using the Max Length Difference. If, however, an explicit override rule is required, then the **Extra Delay Length** can be assigned (see below).

Extra Delay Length

The **extra match** strings can also have an optional **Extra Delay Length** assigned to them. This is done using the extra match button but then using an explicit **Extra Delay Length** value. This means the extra match item(s) must be that length longer than the base match item to satisfy the rule. The value can also be negative meaning it must be shorter that the base item.

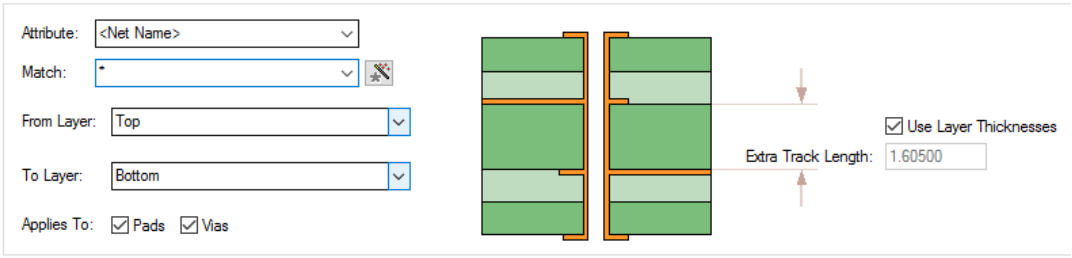
Attribute Name	Match Value	Extra Delay Length	Max Length Difference
Length Match	RDQ48-59	0.000	1.000
<Signal Path Name>	*Branch*	0.000	0.500
Length Match	J1[U8,9,10,17]	0.000	1.000
<Net Name>	DM6	0.000	1.100
	DM7	2.000	



Layer Change Length Rule

The **Layer Change Length Rule** allows you to add an extra length to vias or pads using a layer span rule. By default, track lengths are calculated without taking any account of this additional length. These rules allow you to specify this. This rule can be used in conjunction with the **Track Length Rules** or **Track Length Match Rules**.

Attribute Name	Match Value	From Layer	To Layer	Applies To		Extra Track Length	
				Pads	Vias	Use Layer Thicknesses	Length
<Net Name>	*	Top	Bottom	☑	☑	☑	1.60500



Applies To: - this enables you to specify whether the rule applies to only **Pads** or only **Vias** or both. You cannot have both check boxes not selected.

Extra Track Length: - this allows you to specify the rule. By using the layer span, you can define a thickness that gets added to the overall track length. This additional length can be derived using the layer **Material** thickness and layer setup from the **Layers** dialog or can be specified directly as a typed value by unchecking the **Use Layer Thickness** check box.

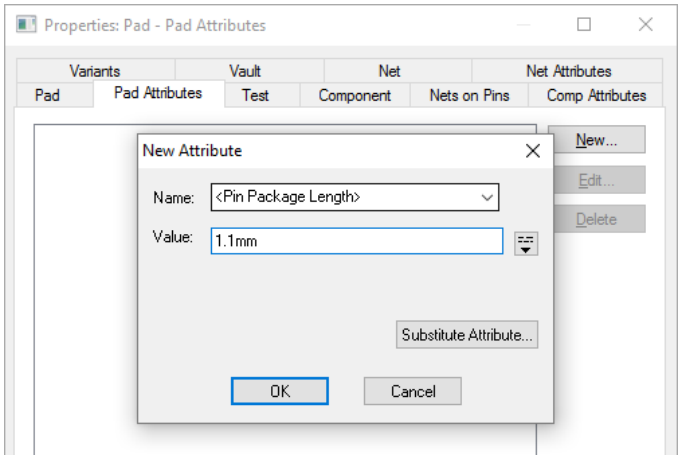
Extra Length Rule through Pin Package Attribute

As well as the general **Layer Change Length Rule** that can be added to layer spans, Pulsonix also provides you with a built-in **Pad Attribute** that can be used on a pad. The attribute <Pin Package Length> can be used to define a pin length or the internal length between two pins say, for a Signal Path to add extra length to the overall track length for **Pads** or **to define an internal length within a component** (the pin package length). This rules comes into effect particularly where bus clock speeds of 500Mhz or above are being used. It is used to add extra length to the net length calculations

There isn't a Rule page for this but it fits here in relation to the above **Layer Change Length Rule.**

The extra length is defined on an IC manufacturer's datasheet and defines a pins internal package length. The internal bond wire to the die introduces a delay to the signal. This delay information can usually be found in the IBIS 6 document for the device.

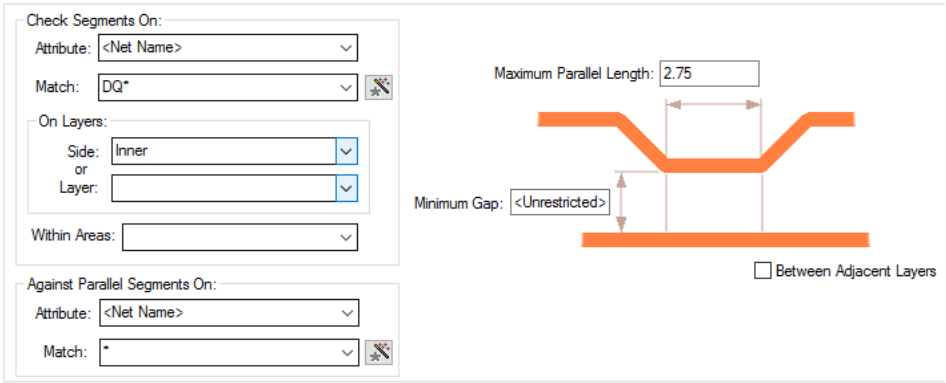
Within the design, the **<Pin Package Length> attribute** can be added to any pads or in Parts if you wish to account for internal package lengths. It should be added using **Properties** of a **Pad**, **Pad Attributes** and adding the <Pin Package Length> attribute plus a length value. The **Value** should also have units defined otherwise the current design units will be used. This could be a problem if swapping design units dynamically and the wrong length being used. The value should be the length of the continuation of the net inside the package.



Track Parallel Segments Rule

A rule is available in **Rules – High Speed** for defining **Track Parallel Segments**. This is used to define the maximum length of two parallel segments. You can also define the minimum gap between the parallel tracks. Both rules can be used on the same or adjacent layers.

Check Segments On					Against Parallel Segments On		Parallel Track Segments		
Attribute Name	Match Value	Side	Layer	Area	Attribute Name	Match Value	Between Adjacent	Min Gap Between	Max Parallel Length
<Net Name>	DQ*	Outer			<Net Name>	*	☐	<Unrestricted>	3.00000
<Net Name>	DQ*	Inner			<Net Name>	*	☐	<Unrestricted>	2.75000



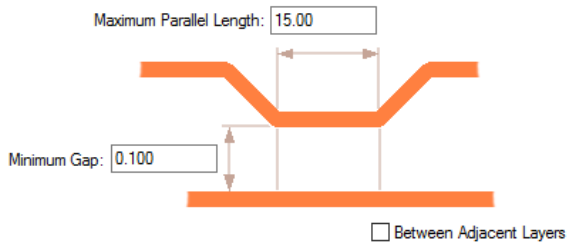
If the **Minimum Gap** is left undefined <Unrestricted>, it will use the default Track to Track spacing rule defined in the **Spacing Rules** dialog.

You can also define multiple rules between two sets of tracks with increasing minimum gaps.

Check Segments On					Against Parallel Segments On		Parallel Track Segments		
Attribute Name	Match Value	Side	Layer	Area	Attribute Name	Match Value	Between Adjacent	Min Gap Between	Max Parallel Length
<Net Name>	DQ48				<Net Name>	*	☐	0.100	15.000
<Net Name>	DQ48				<Net Name>	*	☐	0.150	17.000

How the rule works

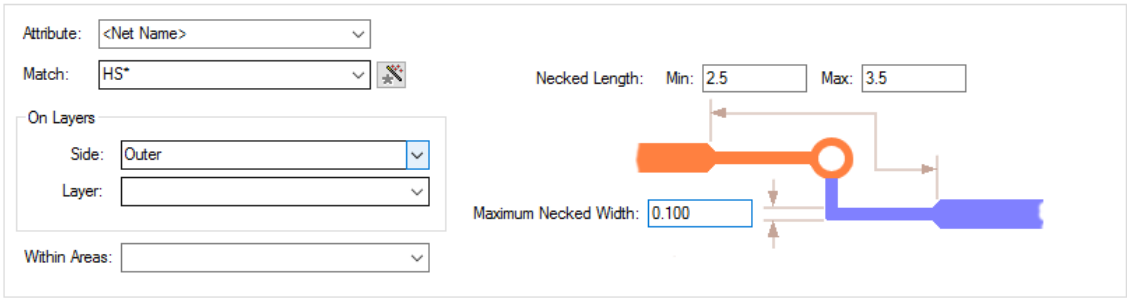
For the example below, the rule is: if the two tracks are within the minimum gap of 0.100mm, you cannot have a run of longer than 15.00mm



Necked Length Rule

Where designs require restrictions applied for the min and max lengths of necked lengths, these can be defined in the **Necked Length Rules** dialog.

Attribute Name	Match Value	Side	Layer	Area	Max Necked Width	Necked Length	
						Minimum	Maximum
<Net Name>	HS*	Outer			0.10000	2.50000	3.50000



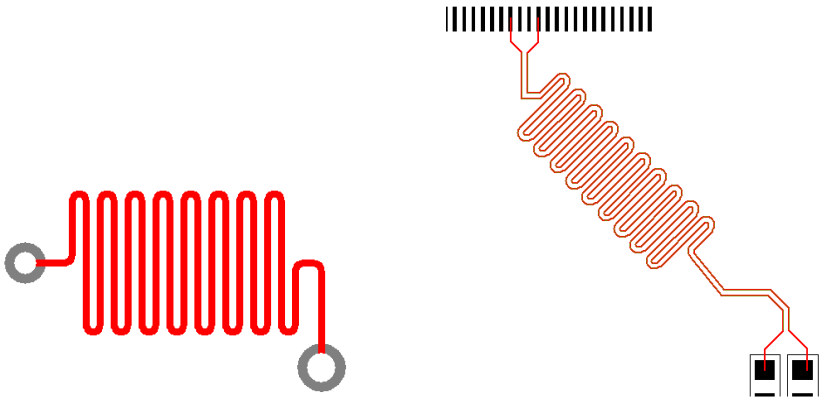
Minimum & Maximum Necked Length defines the minimum and maximum lengths that a track can be necked in a single run before ending or returning to a width thicker than the Maximum Necked Width.

The **Maximum Necked Width** defines the maximum track width that is considered necked. This is an actual width regardless of the default track styles of the actual track style used.

Serpentine Routing

Fixed Rule Serpentine Routing

For balancing the length of high speed nets is the insertion of track ‘length’ without introducing spacing errors. This is commonly known as **Serpentine Routing**. Serpentine Routing can be applied across 90 degree or 45 degree track segments. It can also be applied to differential pair routing (shown below, right).



You can select a track segment (or segments) and run the **Serpentine Routing** command from the context menu which prompts for the serpentine parameters. Parameters are defined for the amplitude

and separation of each loop. You can also define the minimum number of loop cycles to insert, and also the amount of additional length required (otherwise it will do as much as possible).

Serpentine shapes and parameters are defined in the **Technology** dialog and **Serpentine**. If you require length rules to be applied to the tracks, then also other rules available such as **Track Length Rules**, **Track Length Factor Rules** and **Track Length Match Rules**.

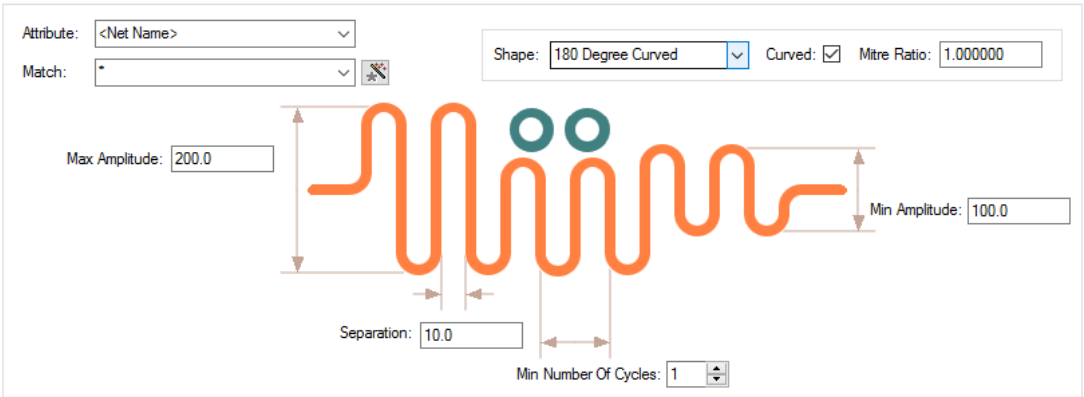
Serpentine Routing Shapes

Using the **Shape:** drop down list, you can choose from different styles of serpentine shapes available or you can customize the ones available to create a variation of these.

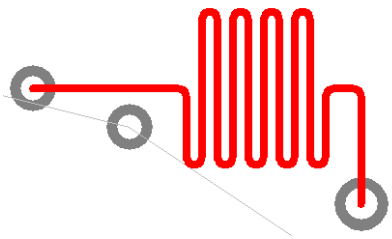
180 Degree Curved

180 Degree Curved will produce a standard serpentine with curved corners. This presets the **Mitre Ratio** to 1.0 and produces 180 degree curved corners. If the **Curved** button is unchecked, it will produce an Octagonal serpentine around the top of the loop although, because it has been 'customised', it will show as User Defined.

Attribute Name	Match Value	Min Amplitude	Max Amplitude	Separation	Min Cycles	Shape	Curved	Mitre Ratio
<Net Name>	*	100.0	200.0	10.0	1	180 Degree C	☑	1.000000

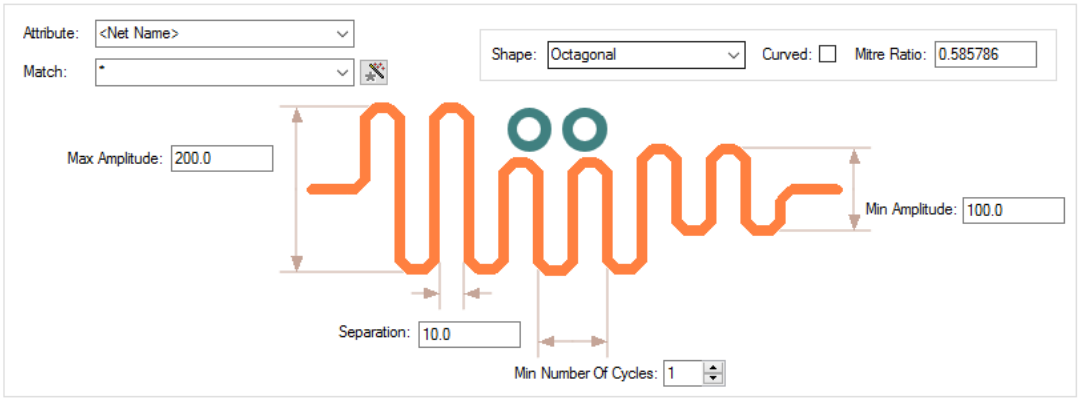


You can define two amplitudes that it can use to automatically reduce the amplitude to avoid obstacles, shown below.



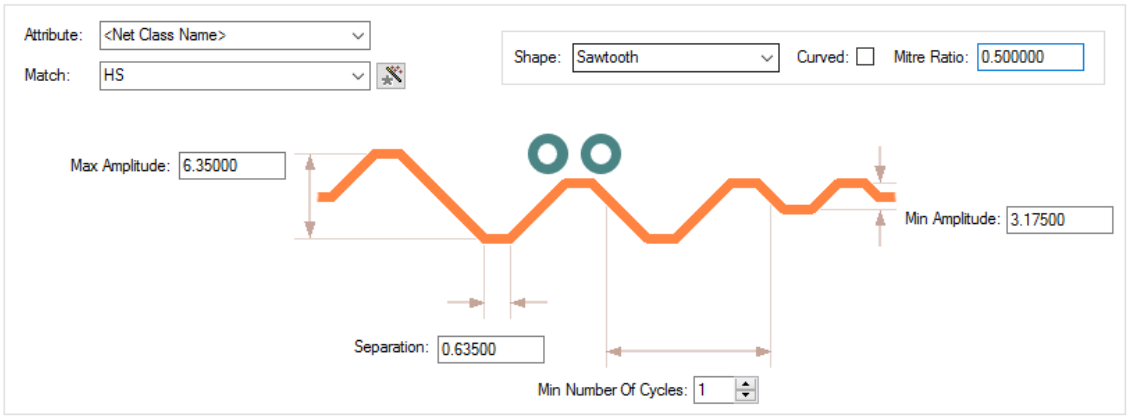
Octagonal

Octagonal produces a serpentine with the 45-degree mitre and flat 'top' lengths the same value.



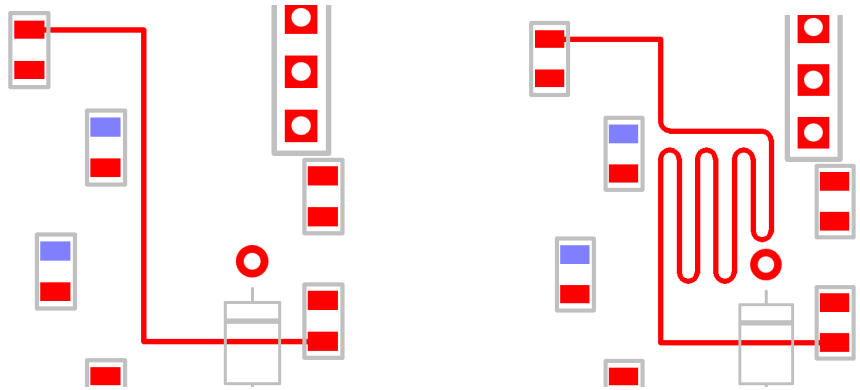
Sawtooth

The Sawtooth shape allows you to define **Min** and **Max amplitude** as well as **separation**. Changing the **Mitre Ratio** will adjust the sawtooth shape allowing more 'flat' spots on the waveform.

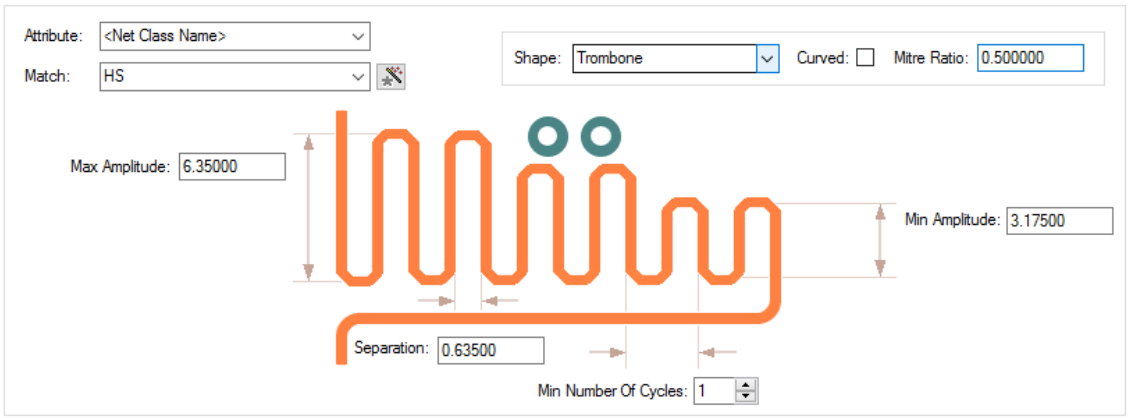


Trombone

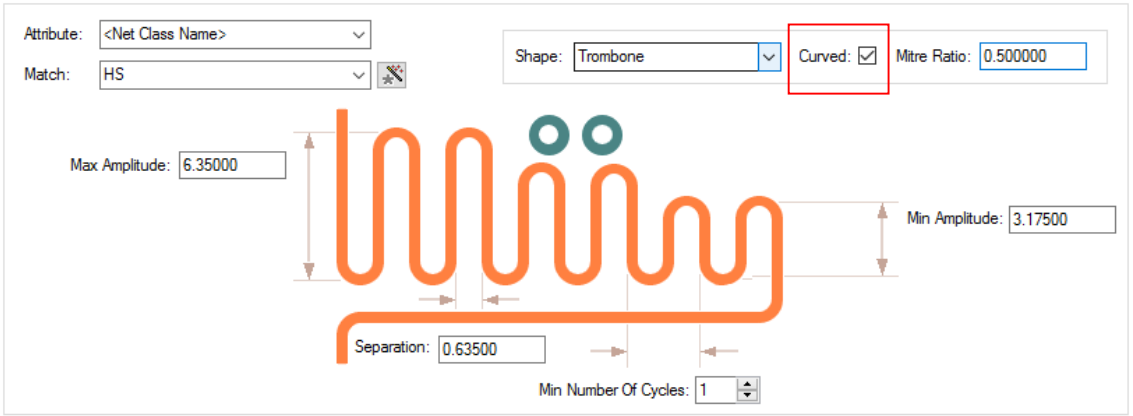
The **Trombone** style breaks into the track and edits it into the trombone shape. The pictures below show the track before serpentine routing and after:



Two styles are available for **Trombone** – **Octagonal** and **Curved**.



Check the **Curve** button to toggle between **Octagonal** to **Curved** shapes.

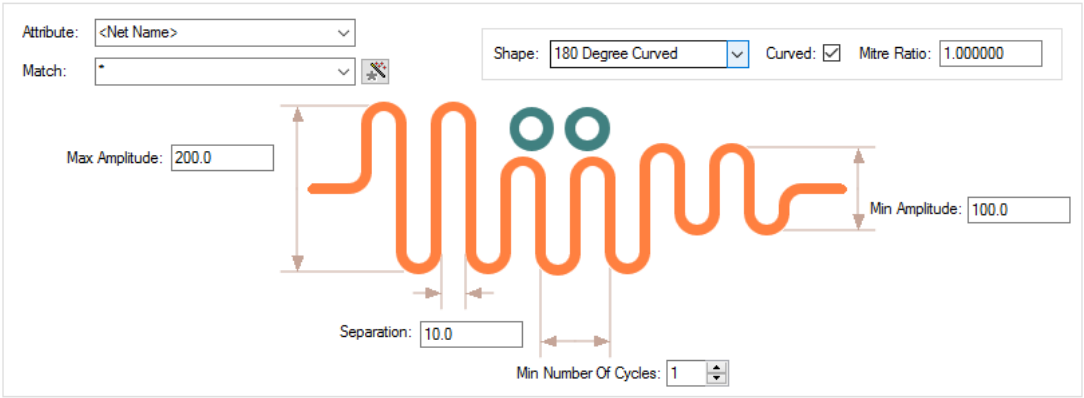


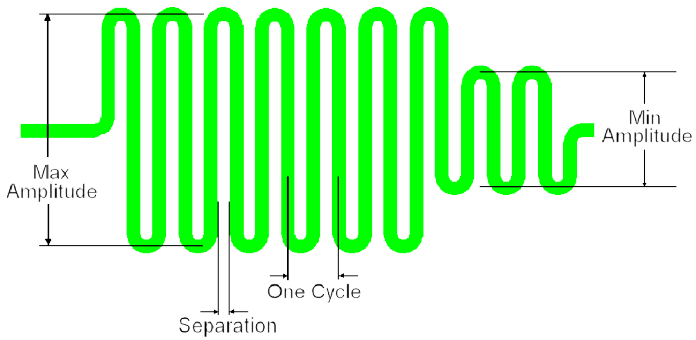
User Defined

If the value is set to a value not matching the above cases, the shape drop down is displayed as **User Defined**.

Shape Parameters

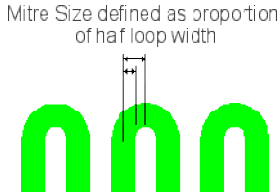
You can define the serpentine with parameters that control the Amplitude and shape of the mitred corners. Mitred or curved corners can range from 180 degree curves to 90 degree corners.





Shape

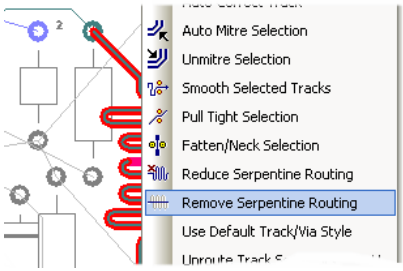
You can control the shape of the top of each loop. The mitre around each turn can be curved or straight, and the size of the mitre is defined by the **Mitre Ratio**, which is the proportion of the 90 degree corner taken up by the mitre. A value of 1.0 gives a complete 180 degree curve (or *sawtooth* if straight) around the top of the loop; a value of 0.0 gives a squared off top to the loop; values in between give a loop of two curves or 45 degree angled lines with a flat top between. The default is **Curved** with a **Mitre Ratio** of 1.0, which results in 180 degree curve around the loop.



A **Mitre Ratio** of 0.585786 and straight mitre gives an octagonal shape around the loop (angled mitres and flat top with the same length).

Remove Serpentine Routing

From the context menu, for a selected track the **Remove Serpentine Routing** feature can be used to remove a selected section of serpentine routing. It can also be used to remove all serpentine routing from the design.

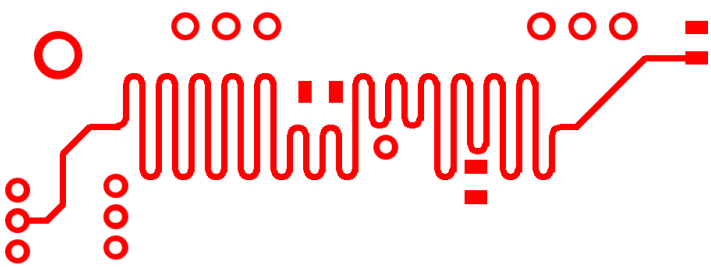


Reducing Serpentine Routing

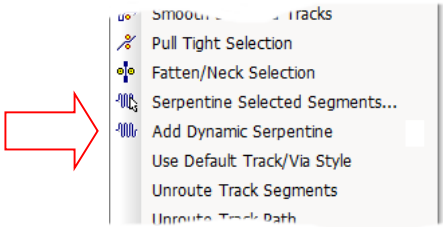
Also on the context menu is the **Reduce Serpentine Routing** feature to reduce a selected section of serpentine routing by one 'loop'. This enables it to be easily trimmed to the correct length without interactively editing the track.

Dynamic Serpentine Routing

Serpentines tracks can be created and edited using the interactive serpentine tool. The serpentine track can be added by selecting and dragging along a track and automatically finishing once the correct length is met. This can be done once a track has been added to the design to increase or decrease its length. Obstacles will be avoided with Online DRC enabled; the serpentine tool will increase/decrease its size around obstacles. Interactive Serpentine will work continuously around angled and curves.



To facilitate this, the **Add Dynamic Serpentine** mode is available on the context menu for a selected track segment. This mode can also be assigned as a command to a shortcut key for fast deployment.



This mode can also be invoked from the **Utilities** menu, **Serpentine** >, **Serpentine Mode** option.

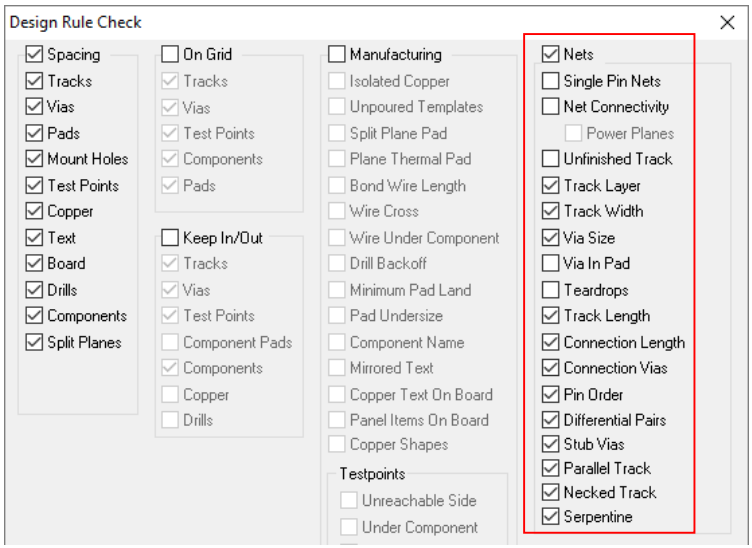
You can interactively add a serpentine by dragging along a track and automatically finishing when the correct length is reached. You can edit a serpentine to change its size, but still adhere to a length rule. With Online DRC switched on, the serpentine reduces its width in places to avoid obstacles, and pushes tracks out of the way if it can.

Once a track has had a serpentine applied to it, that serpentine is remembered by the system and can subsequently be edited with all rules and values available.

The dynamic serpentine mode can be applied to Tracks and Differential Pairs, as well as one track of a Differential Pair to create a 'skew' (this requires the **Differential Pair Skew Rule** to be defined in the **Technology**).

DRC Checks for High Speed Rules

Various checks can be carried out by the **Design Rules Check** dialog for High Speed rules. Use the check boxes under the **Nets** section to define the checks required.



Design Rules for checking available for the High Speed option are: **Track Layer**, **Track Width**, **Via size**, **Track Length**, **Connection Length**, **Connection Vias**, **Pin Order**, **Differential Pair**, **Stub Vias, Parallel Tracks, Parallel Track**, **Necked Tracks** and **Serpentine rules**.

Reporting High Speed Rules and Results

Standard Reports

Standard reports are supplied for reporting rules with high speed parameters assigned to them:

Critical Nets Report

Differential Pairs Report

The reports are additional to the reporting on each of the **Rules** pages within the **Technology**. Each one of these will report its own rules specialty, such as **Where Used** for **Serpentine Rules**.

Custom Reports Using Report Maker

Features within the **Report Maker** enable all aspects of high speed design nets to be reported using commands available.

Interactive Bus Routing

As part of the **Interactive High Speed** option, in a PCB design, you can add and edit multiple parallel tracks at the same time representing groups of signals such as Memory, Differential Pairs and Buses that need to be routed together using the **Bus Route** option. Like Differentially Paired tracks, the tracks added to a Bus route are kept together when moving or editing them; treated as if they are a single item.

The option can be used to quickly add a set of tracks on new nets to a design representing a channel that can be connected to existing nets at a later stage, or can be used to route together a group of signals that already exist in the design.

To aid this feature further, names of Busses in Schematics, and the Nets within them are synchronised to the PCB design so that when adding PCB Bus routes you can choose the signals required by using the Schematic Bus Names from the context menu.

Insert Bus Route has three phases:

- Select the items (Pads, Vias, Track ends, Connections (Nets)) that you wish to start from and select the option.
- Position the line of junctions at the start of the Bus route that represent the start point of each track in the set.
- Add segments to define the path of the Bus route.

▶ To add Bus routes

Use the **Bus Route** option from the **Insert** menu.

The corners of the centre line of the Bus route will be gridded.

When the mode is entered, **Insert Bus Route** is displayed on the **Status Bar**. Use the following steps to add a multi-track path:

1. First, if another track is pre-selected before entering the mode, the width and layer are taken from the selected track segment to use when adding the tracks in this session. These are shown on the Status Bar.
   The pre-selected track will remain selected until picking is done in the Insert Bus Route mode.
2. Alternatively, if a set of pads or vias are pre-selected these will form the set of nets to be routed together.
3. Before you select an item to start the track from, you can right click the mouse to use the shortcut menu to do the following:-

   Change Layer - Use this to set the layer that you wish the tracks to be on. This layer is used if the picked pads to start from reaches it, otherwise the layer the start pads are on will be used. The new layer is shown on the status bar. You can also use **Next Layer** and **Previous Layer** to step through the different layers.

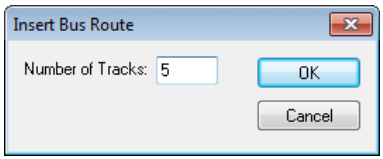
   Change Style - Use to change the width of the tracks to a specified value. This value will be used even if the picked item is already on a net and has a track style associated with a net class. The new style is shown on the status bar.

   Use Default Style - Use to change the width of the track back to using the default style. The style on the status bar is cleared to indicate that the track style will be defaulted as follows:-

   For new nets the track style will be taken from the **Net Class** defined on the **Nets** page of the

Technology dialog. If the track is started on an item that is already on a net, the track style will be taken from its net class.

Change Number of Tracks - This option is available if you do not have any items selected and is used to specify how many tracks you want in a Bus route containing new nets. The number of tracks that will be added is displayed in the Status Bar at the bottom of the screen.



Show Dynamic Cons Only – Use this option so that you can only see the connections from the end of the bus route to their target pads.

Route Connections At Bus Start - Switch this on if you want the dynamic unrouted connections at the start of the Bus routing to be converted to tracks as soon as you select the position to start the Bus route from. A simple routing algorithm will be used that does not allow layer changes or complicated patterns to be created. If the connections cannot be routed simply, they will be left unrouted for you to complete later.

Segment Mode - use this sub-menu to change the track segment mode that will be used. This affects what direction the Bus route can be started. This will include 45 degree angles if the current track segment mode is not purely Orthogonal.

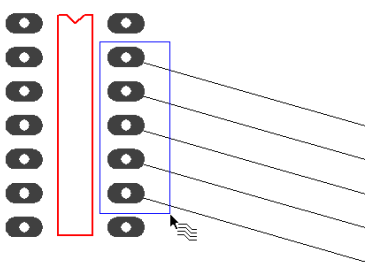
4. As soon as you enter the **Insert Bus Route** mode a modal cursor will be displayed for you to use. If you want to use existing nets in the Bus route, select the items to start on as follows:-

Click on a component pad, via or dangling track end. Its selection state will be toggled.

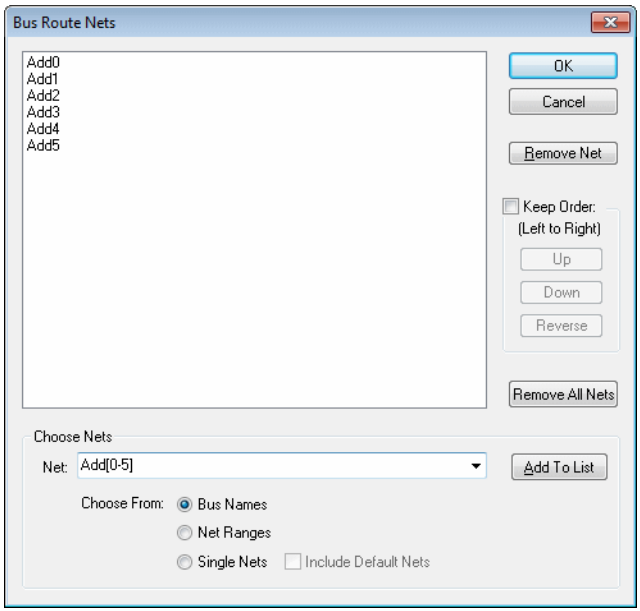
Drag a frame to select a set of component pads, vias or dangling track ends. This set of items will define the Bus route unless the control key was held down when ending the frame, in which case you will be able to carry on selecting or deselecting items.

Click the mouse on an unrouted connection.

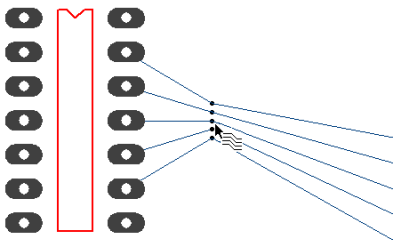
Do not select any items. A new Bus route will be started from the position you picked. The tracks will be placed on new nets and connected to junctions at their start and end points.



Use **Define Bus Route Nets** to choose nets, the closest items on these nets will be used. If it is difficult to pick items to define the nets you want in the bus route, use this option to choose the required nets from a list of net names in the design.

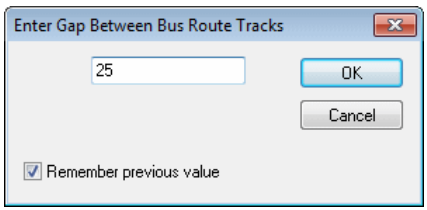


5. Click in space to start the Bus routing. If a set of pads, vias or connections have been selected you will enter a positioning phase to pick the start point of the centreline of the Bus route. During this phase, dynamic dots of the correct track width and separation will be displayed to show you where the tracks will start and what direction the first track segments will be. This will include 45 degree angles if the current track segment mode is not Orthogonal. The mode can be changed using the shortcut menu.



6. You can use options on the context menu at this stage to alter the gaps between the tracks that will be added.

Define Gap Between Tracks - Use this to exactly set the gap between the edges of adjacent tracks to a typed value. This is useful if you are adding a Bus route to represent a differential pair where the gap has to be an exact value. Note: the specified gap will only be used if it is not less than the Track to Track spacing.



Use Minimum Gap Between Tracks - Use this to make the tracks in the Bus route as close as legally possible to each other. It will use the relevant Track to Track spacing between each pair of tracks.

Use Gaps Between Start Items - Use this to set the gaps between the tracks in the Bus route so that they are in-line with the start items. This is useful when using track routing to add memory routing.

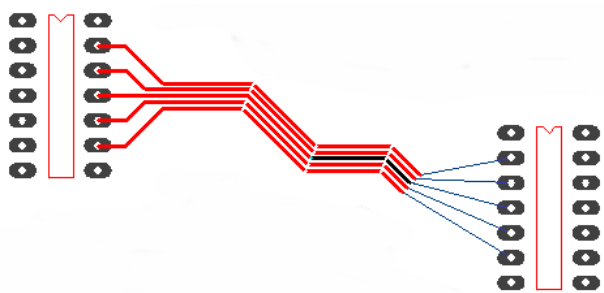
Increase Bus route Gaps - This is available if you previously used the Minimum Gap. Each time you use it the tracks will be spread out by another grid step.

Decrease Bus route Gaps - This is available after using Push Tracks Further Apart to bring the tracks closer together by reducing their offset by a grid step. You can use it until the minimum gap is reached.

7. Now left click to pick the position to start the Bus route from.

You now have a new set of parallel tracks dynamically displayed on the screen and are ready to add their track segments. If you had the **Route Connections At Bus Start** switch on (see above) the dynamic unrouted connections at the start of the Bus routing will be converted to tracks. If the connections cannot be routed simply, they will be left unrouted for you to complete later.

If you are adding an odd number of tracks in the Bus route you will be controlling the middle track of the set with the cursor, and it will be added on grid just like if you were adding a single track. If you are adding an even number of tracks, a dummy thin track will be added in the middle for you to control on grid. When you have finished adding the dummy track it will be removed. The rest of the tracks will be created either side of the middle track you are adding. This is similar in operation to the **Edit Track** mode except multiple tracks are added together.



The first track segment added will be forced to use the selected start direction away from the start items. Once you have left clicked once to add the first corner, free movement can be used. The segment mode used can be changed from the context menu. Note that small tight corners created in the middle track path might give strange results for the outer tracks being added if they do not have not enough room to maintain their required gap.

Whilst adding the track segments you can change the gap between the tracks using the various options from the context menu described above (**Define Gap Between Tracks**, **Use Minimum Gap Between Tracks**, **Increase Bus Route Gaps** and **Decrease Bus Route Gaps**). Note that **Use Gaps Between Start Items** cannot be used at this point. When the gaps are changed, if you had the start connections routed they will be re-routed to accommodate the new track start positions.

8. Once the required path has been added, there are several ways of finishing as follows:

   Use **Left Double Click** in space, or the **Finish Here** option from the context menu to finish the tracks at the cursor position, leaving the trailing connections as they appear on the screen.

Use the **Complete As Track** option from the context menu to finish the Bus route at the cursor position and attempt to convert the dynamic unrouted connections at the end of the Bus route to tracks, finishing on their end items. A simple routing algorithm will be used that does not allow layer changes or complicated patterns to be created. If the connections cannot be routed simply, they will be left unrouted for you to complete later.

Move the end of the Bus route over a previously created Bus route that contains at least as many tracks as you have in the dynamic Bus route. This is best done by approaching the existing Bus route at the same angle as its last segment. When the end of each dynamic track is over one of the tracks in the existing Bus route a finish marker dot will be shown (if the finish markers are displayed). At this point pressing left click should join each track in the dynamic Bus route to its corresponding track in the static one.

After finishing the tracks you will be ready to select a different set of pads to add the next Bus route from, or use the <**ESC**> key to exit the Bus route mode.

Editing Bus Routes

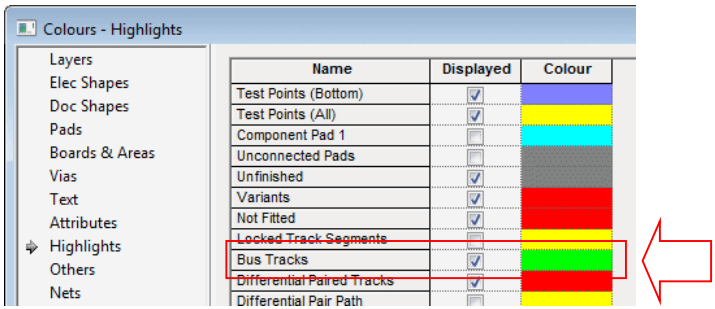
After creating a Bus route you can edit it again as a single item, just like Differential Pairs. Individual tracks within it can be edited as normal, but doing this makes it hard to maintain the gap between the tracks. The method of changing a Bus route's path is to remove track segments in the middle and add a new Bus route, starting from the dangling set of dangling tracks at one end and ending on the dangling set of tracks at the other end. Start the new Bus route by framing over the dangling ends of the existing Bus route. The gaps between the parallel tracks will be kept to match the existing Bus route.

Use the **Cut Track** interactive option to remove track segments from the Bus route as it will cut the tracks in a nice line ready for adding a new Bus route from.

This method can also be used to split a Bus route to go around an obstacle or to drop the outer tracks and continue adding a Bus route with less tracks. Just frame the correct number of route ends that you wish to continue with the next Bus route.

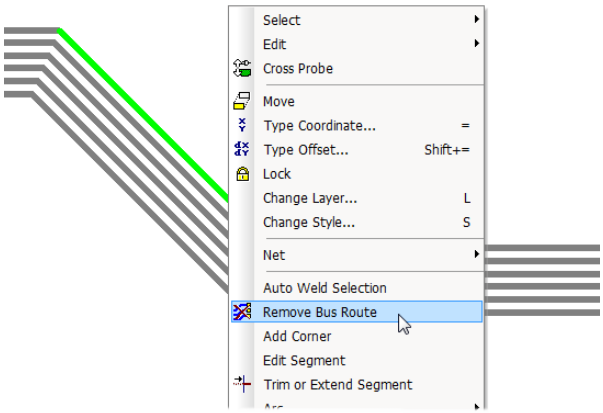
Bus Route Colours

There is a highlight colour for tracks in a Bus route, use the **Colours** dialog, **Highlights** tab and **Bus Tracks**.



Removing Bus Routes

You can use **Remove Bus Route** from the shortcut menu to convert the parallel tracks back to ordinary tracks again.



Cut Track

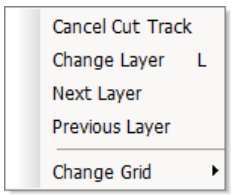
The **Cut Track** function (see below) has been added to make it easy to remove and add new parallel segments in a bus route.

Cut Track

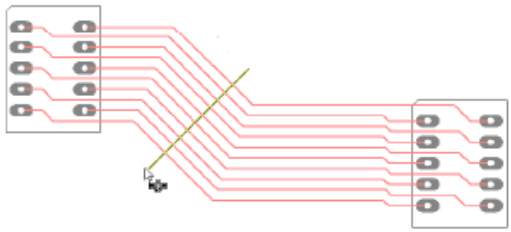
In PCB designs you can use the **Cut Track** tool from the **Edit** menu to define two cut lines and remove any section of track path between the two cuts. This can be applied to multiple tracks, such as those used in a **Bus Route** and also includes **Differentially Paired** tracks. This feature is not part of the Interactive High Speed option but is documented here for completeness.

▶ To use cut track

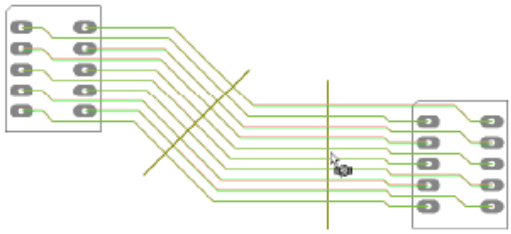
1. Select the **Cut Track** option from the **Edit** menu. You will notice the cursor change to the Cut Track modal cursor.
2. Before you select the tracks to cut you can right click the mouse to use the shortcut menu to **Change Layer** to the layer containing the tracks to be cut.



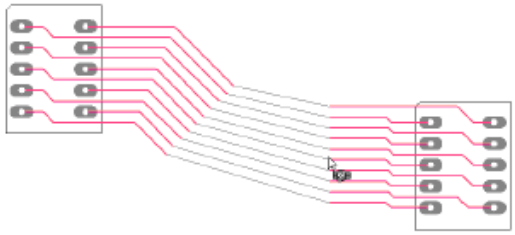
3. Select an electrical layer, or select [Through Board] to cut tracks any layer. The chosen layer will be displayed on the status bar at the bottom of the screen.
4. Use two left mouse clicks to define the start and end points of the first cut line, or drag the cursor to define the cut line. The position of the second point will be restricted to make the angle of the line a multiple of 45 degrees.



5. All track paths crossing it will be highlighted indicating they are available to be cut.
6. A second dynamic cut line will be displayed at the same angle and length as the first line for you to position with your cursor. You can use the **Rotate** option from the context menu to rotate this line in 45 degree steps to align the cut perpendicular to multiple track segments that are to be cut.



7. Drop the second cut line over highlighted tracks to cut them.
8. If you need a different length or different angle second cut line, it can be changed by moving its centre to where you want the second cut to start and dragging the cursor to define the length and angle of the line.
9. When both cut lines have been defined the highlighted tracks will have their segments between the lines removed.

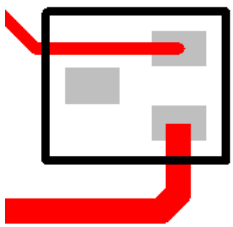


10. This will result in the tracks being split in two by having the section between the two cuts removed unless one of the cut lines is over the track start or end point.

RF Design Features

Square-ended Tracks

To support the creation of RF designs, tracks can have square ends instead of rounded ends.



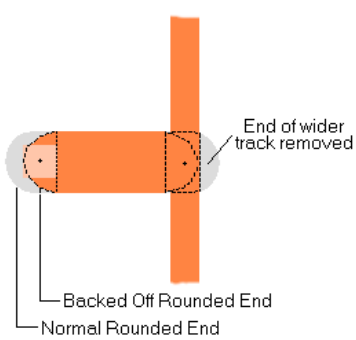
These is defined in the **Technology** dialog under **Track RF Rules**.

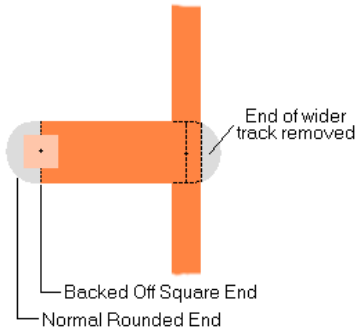
You must have the **Back Off Track Ends** enabled for the **Square Track Ends** to also be enabled.

Back Off Track Ends

Enabling **Back Off Track Ends** will cause track ends to be moved back so there is no overshoot. This is only applied to tracks which would otherwise cause an overshoot, and which have sufficient length for the track to be backed off. **Design Rule Checking** will take the back off into account, allowing tracks to end more closely to other obstacles than would normally be the case. Tracks will be backed off at width changes and T-Junctions, as well as where they terminate at a pad.

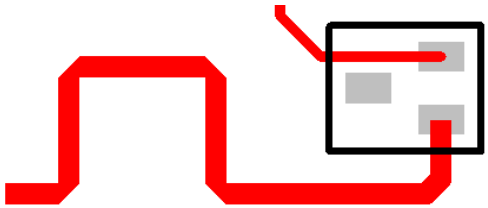
You have a choice of how these backed off track ends are finished. They are either **Round Track Ends** or **Square Track Ends**, see the diagrams below to see the difference.



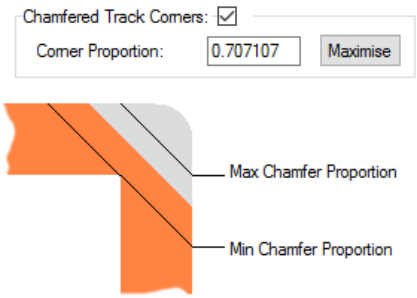


Chamfered Corners on Tracks

For the support of RF designs you can create RF mitres in Pulsonix, these are called **Chamfered Corners**. Parameters allow Track corners to be chamfered (45 degree outside corner and 90 degree inside corner).



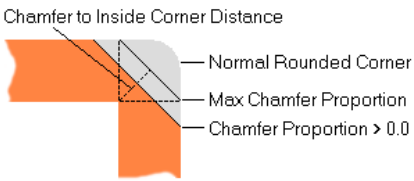
The Chamfered Corner feature is available as a rule that can be set on any net item using the **Track RF Rules** page within the **Technology** dialog. For each net that requires this style of track corner, edit the **Net Class** and on the **Special Routing** page, select the **Chamfered Track Corners** option.



Enabling **Chamfered Track Corners** causes orthogonal corners to be drawn with a 45 degree chamfer instead of the normal rounded corner. Note that the corner is still considered rounded for spatial checking purposes. This gives an over estimate of the space occupied by the chamfered corner. Corners are only chamfered if the track is orthogonal and there is sufficient distance to complete the chamfer before the next corner.

The size of the chamfer is controlled using the **Chamfer Proportion**. The value gives the distance between the inside corner and the outside chamfer as a proportion of the track width (or the minimum width if the two track segments are different widths). So a value of 0.5 and a track width of 20 thou would cause the distance between the inside corner and the chamfer to be 0.5 x 20 = 10 thou. The value can be between 0.0 and the reciprocal of the square root of two (0.707107).

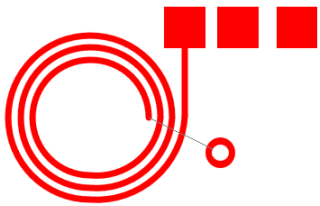
Use the **Maximise** button to set the maximum value. The maximum value gives a chamfer across the width of the track. A value nearer to 0.0 will lengthen the chamfer and decrease the distance between the chamfer and the inside corner.



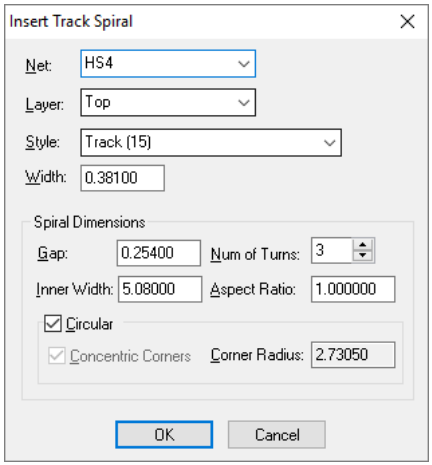
Spiral Tracks and Shapes

As part of the increasing support for RF designers, you can use Pulsonix to insert a **Copper** or **Track Spiral** (and **Breakouts** in footprints).

Insert Spiral is available on the **Insert** menu for **Shapes** and **Tracks**. This feature can be used for designing spiral inductors and planar transformers for example.



When adding the spiral, various parameters allow you to control its shape.



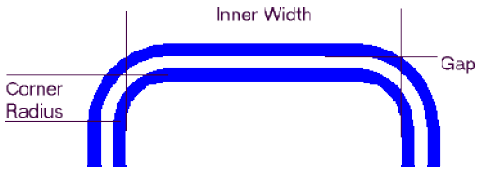
Select the **Net** to connect the spiral to. For tracks you must select an existing net, but Copper does not have to be on a net.

The **Layer** box is used to select the layer to place the spiral on.

Style is used to select the track/copper Style of the spiral. You can also type a **Width**.

Spiral Dimensions

The spiral always begins at the inner right side and ends at the outer right side (but you can rotate or mirror it later).



The **Gap** is the distance between each *turn* of the spiral excluding the segments **Widths**.

The **Num of Turns** is the number of complete *loops* of the spiral.

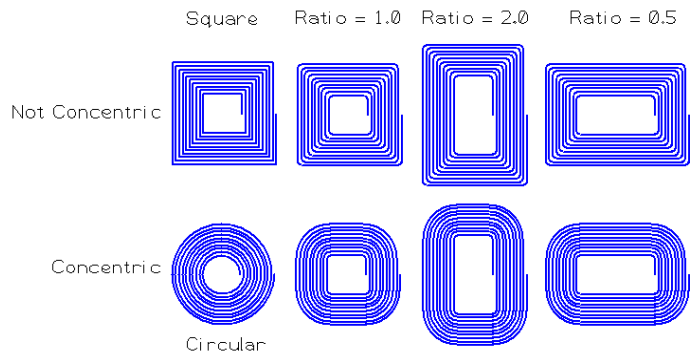
The **Inner Width** is the distance across the inner void of the spiral.

The **Aspect Ratio** allows you to create *rectangular* spirals and is the ratio of **Height / Width**. So an **Aspect Ratio** > 1.0 gives a **tall** spiral, and < 1.0 gives a *Wide* spiral.

The **Corner Radius** is the initial inner radius of the corners of the spiral.

Concentric Corners gives you *tight* corners which are properly nested, increasing in radius as the number of turns increases. Otherwise the corners are fixed at the **Corner Radius**.

The **Circular** option fixes **Concentric Corners** on, and the **Corner Radius** to be half the **Width** plus the **Inner Width**. This has the effect of giving near circular spirals. A zero **Corner Radius** and not **Concentric Corners** will give you square corners.



Note: Spirals are added normal track and copper, to modify, you should use delete and then add another one.

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