Title: Differential Pairs in Performance Option

Product: Allegro PCB Editor with Performance Option

Summary: Working with Differential Pairs.

Author/Date: Beate Wilke / 15.04.2009

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1 Differential Pairs

1.1 Before you start

This Application Note is based on the Application Note “Start with electrical constraining”. It’s important to check and set all necessary settings before you start with electrical constraints. If you do not have the Application Note “Start with electrical constraining”, please contact FlowCAD Hotline – support@flowcad.de.

1.2 Definitions

In this picture you see the electrical workbook in Constraint Manager. To create an electrical Rule Set you need a good understanding of how the different fields work.
1.2.1 Type

The field Type shows the Type of the following element. Here is a list of all possible Types:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dsn</td>
<td>Design</td>
</tr>
<tr>
<td>DsnI</td>
<td>Design Instance</td>
</tr>
<tr>
<td>Lyr</td>
<td>Layer</td>
</tr>
<tr>
<td>PrtD</td>
<td>Part Definition</td>
</tr>
<tr>
<td>PrtI</td>
<td>Part Instance</td>
</tr>
<tr>
<td>GtI</td>
<td>Gate Instance</td>
</tr>
<tr>
<td>Bus</td>
<td>Bus</td>
</tr>
<tr>
<td>MGrp</td>
<td>Match Group</td>
</tr>
<tr>
<td>DPr</td>
<td>Differential Pair</td>
</tr>
<tr>
<td>Xnet</td>
<td>Extended Net</td>
</tr>
<tr>
<td>Net</td>
<td>Net</td>
</tr>
<tr>
<td>PPr</td>
<td>Pin Pair</td>
</tr>
<tr>
<td>NCls</td>
<td>Net Class</td>
</tr>
<tr>
<td>NCC</td>
<td>Net Class-Class</td>
</tr>
<tr>
<td>Rgn</td>
<td>Region</td>
</tr>
<tr>
<td>RCIs</td>
<td>Region Class</td>
</tr>
<tr>
<td>RCC</td>
<td>Region Class-Class</td>
</tr>
<tr>
<td>Rslt</td>
<td>Result</td>
</tr>
<tr>
<td>PCS</td>
<td>Physical Constraint Set</td>
</tr>
<tr>
<td>SCS</td>
<td>Spacing Constraint Set</td>
</tr>
<tr>
<td>RCC</td>
<td>Region Class-Class</td>
</tr>
<tr>
<td>SNSC</td>
<td>Same Net Spacing</td>
</tr>
<tr>
<td>ECS</td>
<td>Electrical Constraint Set</td>
</tr>
<tr>
<td>RBnd</td>
<td>Ratsnest Constraint Set</td>
</tr>
<tr>
<td>RPPr</td>
<td>Ratsnest Bundle pin pairMember</td>
</tr>
</tbody>
</table>

1.2.2 Objects

The “Object” field stores the Name. If the Type is DSN the Object field includes the board file name. If the Type is ECS the Object includes the name of the Electrical Constraint Set.

1.2.3 Uncoupled Length

Uncoupled Length contains the settings for the total etches length which is not routed using Primary or Neck Gap.

Gather Control:
Gather Control defines if the last cline segments before entering a pad or via are added to the uncoupled length.

The possible settings are “Ignore” or “Include”.
- **Ignore**: The uncoupled length for pad entry is not added (ignored) for the uncoupled length.
- **Include**: Includes the uncoupled length for pad entry to the uncoupled length.
Max uncoupled length:
It’s almost impossible to route a differential pair without any uncoupled length. The Max value defines the maximum total amount of uncoupled length of one differential pair.

1.2.4 Phase Tolerance

Enter the maximum Phase Tolerance in mm or ns for the differential pair. If you have critical nets, the same length or delay is very important for the signal quality.

To optimise same length or delay, you can tune the shorter signal.

1.2.5 Min Line Spacing

The Value is Primary or Neck Gap minus (-) Tolerance, use the smaller value. You need to set this value if it’s smaller than the spacing rules. Min Line Spacing in a differential pair rule overwrites the rules from spacing constraints. Otherwise you would get spacing errors.

1.2.6 Coupling Parameters

1.2.6.1 Primary Gap

Primary Gap is the primary or standard value for the distance between the 2 clines of a differential pair.
1.2.6.2 Primary Width

Primary Width is the primary or standard width for the clines of a differential pair.

1.2.6.3 Neck Gap and Neck Width

If you have to route within a smaller pattern, e.g. inside a BGA footprint you can use the Neck Routing Mode (select Add Connect -> right mouse button -> Neck Mode). Neck Gap and Neck Width are the values for the Neck Routing Mode.

If you use Neck Mode, please remember to set Min Line Width to the right value.

1.2.6.4 (+) and (-) Tolerance

When routing at 45 degrees or using arc clines the tool needs a tolerance for primary and neck gap.

For horizontal and vertical lines the gap matches the gap value of 0.4 exactly.

For all other lines the gap is slightly different. In this example it’s 0.4064 instead of 0.4.
1.3 Calculating differential impedance

You can use the Cross Section to calculate the impedance. Please see Application Note “Start with electrical constraining” chapter 1.

In the Constraint Manager go to Electrical Workbook -> Electrical Constraint Set -> Differential Pair.

Select Min Line Spacing or a Coupling Parameter -> right mouse button -> change.

Select Calculator. The Calculator window opens. Enable the radio button to the value you want to calculate. Change the other value followed by the tab key until you get the right result.
1.4 Creating an Electrical Constraint Set for one Layer

In Constraint Manager go to Electrical Workbook -> Electrical Constraint Set -> Differential Pair.

Select any of the Objects fields -> right mouse button -> Create -> Electrical Cset.

Type in the name of your constraint set and select OK. Fill in all necessary values. We recommend filling in all values. If you don’t want to use Neck Mode, fill in the same values as for Primary Gap and Width.
1.5 Creating an Electrical Constraint Set for all Layers

When you route the differential pair on different layers, you need to use different values for Width and Gap. Otherwise you will get different impedances on the different layers. Please see the following Cross Section.

In the next Cross Section all impedances are the same because the values for Width and Gap have been changed.
You need to use a physical rule set to set the different values. In the example below you see the different values for Width and Gap we calculated with Cross Section.

In the electrical Cset leave all Coupling Parameters and Min Line Width blank.
1.6 Defining Differential Pairs

In Constraint Manager go to Electrical Workbook -> Net -> Differential Pair. Select 2 single nets which you want to define as differential pair, click the right mouse button -> Create -> Differential Pair. Then enter the name of the pair and select OK.

If you have several differential pairs in your design, do the following: Go to Electrical Workbook -> Net -> Differential Pair -> select the Object field with Type DSN -> right mouse button -> Create -> Differential pair.

Create Differential Pair window opens. Select Auto Setup.
Fill in the Filter values for + and -. If you wish, you can also fill in the Prefix.

1.7 Assigning Electrical Constraint Set to Differential Pair

In the column on the right hand side of the Objects column with the differential pair names you can reference the differential pair Cset you created previously. To reference a single pair to a Cset, only click in the field. You automatically get a choice box with all available Csets.

To reference many pairs, select several fields. In the first row you automatically get a choice box with all available Csets.