Advanced Design System 1.5
Design Rule Checker

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Chapter 1: DRC Quick Start

The Design Rule Checker helps ensure that a layout design conforms to the physical constraints required to produce it. These constraints can be a requirement of the design itself, such as reducing noise, or a requirement of the process used to produce the design.

You can run a quick check to ensure conformance to basic design requirements, such as minimum width and spacing, or you can run a custom check using prewritten rules to ensure that a design meets manufacturing specifications. In either case, you can check all or part of the design.

Whether you run a quick check or a custom check, the procedure is essentially the same:

- Define or select a design rule.
- Run the design check using the defined or selected rule.
- Load the results.
- View any errors that were found.

DRC Message Window

The DRC Message window provides information on the status of the current Design Rule check. The window displays as you set up and run a DRC and then displays a summary of in the View Errors panel of the DRC or Custom DRC dialog box.
Rule Registry File

A rule registry file, called setrule.ael, is required in a rule directory to display the list of available rule files by file names.

The format of setrule.ael is as follows:

```
dve_set_rule_list(list ( 
    <rule_name_1>, <rule_file_1>, 
    <rule_name_2>, <rule_file_2>, 
    ........ 
    <rule_name_n>, <rule_file_n> 
));
```

where `<rule_name>` can be a string that briefly describes the purpose of the rules and `<rule_file>` is the actual file name.

For example, if you create a setrule.ael file for the Project directory shown below, the Rule Selection dialog displays this list of rules when you click the Project button.

```
// Rule Registry File

dve_set_rule_list(list( 
    "Substrate Via Design Rule", "viaRule.ael", 
    "NiCr Thin Film Resistor Design Rule", "resistorRule.ael", 
    "Gate Metal Spacing Rule", "gateSpacing.ael" 
));
```
Rule Directories

You can store a rule file in any directory and find the file using the Rule File Browser invoked by the Browse button in the Rule Selection dialog box. However, it is better to use one of the three rule directories supported by the program to facilitate rule file browsing. The three rule directories for storing custom rules are: Site, User, and Project. Buttons corresponding to these directories are available in the dialog box. You can find prewritten design rules at each level.
Setting Up a Quick DRC

You can use a quick DRC to check selected components or to check an entire design against basic design requirements. After you provide the information needed, the program writes a design rule for you that you can save and reuse again.

To set up a quick DRC:

1. In the Layout window, create a new layout or open an existing one.
2. From the menu, choose Verify > DRC to open the DRC dialog box. Use the first tab to define a basic design rule to be used.

Minimum Width defines the narrowest allowable value in the design.
Minimum Spacing defines the narrowest allowable spacing between shapes in the design.
Minimum Angle defines the smallest allowable angle in the design.
Apply to Layer(s) displays a list of the layers in the current design. Choose the layers that you want the rule to apply to.
3. Select the parameter(s) you want to check and enter a value in the selected field. Do not include units when you enter a value in this panel.

**Hint** The value you enter should produce at least one error, so you can view results.

4. In the Apply to Layer(s) list select the design layer(s) you want checked.
5. Click Apply to start the process.

**Setting Up a Custom DRC**

Typically you use a custom DRC to check a design against a manufacturing specification. A custom DRC differs from a quick DRC in two major ways:

- You specify a prewritten design rule.
- You must create a DRC layer in the design on which to display error segments.

To set up a custom DRC:

1. In the Layout window, open an existing layout or create a new one.
2. Choose **Options > Layers**. If the design does not have a drc layer, create one.
3. Choose **Verify > Custom DRC** to open the Custom DRC dialog box at the Select Rule tab.

- The **Rules List** displays the design rules in the current project directory.
- The **Rules File** displays the selected rules file.
- **Browse...** displays the Select Rules File dialog box where you can select a rules file from a different project directory.

For details, see "Rule Directories" on page 1-3 and "Rule Registry File" on page 1-2.

4. Choose Site, User, or Project to view predefined rules.

5. Select a rule from the Rules List. The description of the design rules displays in the selected list. If the rule you want is a rule file, you can browse to find it or you can enter the path and rule file name in the Rule File field.
6. Click Apply to compile the selected rule. The DRC Message Window opens and displays a running message similar to the example:

![DRC Message Window]

7. Click OK to save the file.

![Save DRC Rule As]
Running a DRC

To run a DRC:

1. In the DRC dialog, click **Run DRC**.

2. In the Check Area, choose whether you want the program to check the entire layout or only the area that is currently visible in the Layout window. You can save time on large designs by checking only the area of concern.

3. You can accept the default **Job Name** or enter a different name. The default **Job Name** is the design name with the suffix _drc. In either case, include the suffix.

4. Click **Apply** to start the process.

A message similar to the example displays in the message window:

```
Run DRC Job <Job Name>_drc for full design...
DRC process complete
```
Viewing DRC Results

After running a DRC check, you can view the results. See also “Reloading DRC Results” on page 1-13 and “Viewing DRC Errors” on page 1-10.

To view results:

1. In the DRC dialog, select Load Result.
2. In the Job Name list, select the job name you want to view.

3. Click Apply to view the results. A message similar to the example displays in the message window.

Load results <Job Name>_drc
Load results complete
DRC Quick Start

Viewing DRC Errors

After running a design rule check, you can view a summary of the results and any errors found by the check.

---

**Note**  For a quick DRC, the program automatically creates a drc layer on which error segments are displayed. For a custom DRC, the program does not create a drc layer automatically. You must create an appropriate drc layer(s) before you run the check.

---

To view errors:

1. In the DRC dialog, select **View Errors**.

2. Click **First**.

   If there are no errors, the message window displays:
   
   *No DRC error exists!*

   If at least one error exists, the error segment(s) in the Layout window are highlighted and the message window displays:
Error #1:
<design rule>

where <design rule> is what you defined previously in the Define Rule tab. For example:

Width of layer cond must be >= 25.00

3. Enable Auto Select and Auto Zoom, then click First again. In the Layout window, the program zooms in on the area that contains the first error and the error segments are selected so you can delete the DRC segments as you fix problems in the layout.

4. Click Next. If there is more than one error, the message window displays the next error and the program moves the zoomed display in the Layout window to the area that contains the next error.

5. Click Summary. The message window displays a summary similar to the example.

   Job Name: example_drc
   Design Name: example
   Design Rule: <current project directory path>/verification/autorule.ael
   Total Number of Errors: 1

---

**Note** If you prefer, you can view the summary before you view any errors.

To view specific error types:

1. In the Layout window, choose Options > Preferences > Select.

2. Turn off all Select Filters except the specific error type you want to view (for example, Polylines).

3. Click Select by Cursor and experiment with selecting errors by dragging a select box around areas in the layout where errors are indicated.

4. Click OK to dismiss the message window, Cancel to dismiss the dialog box.
Saving a DRC Rule

You can save the rule that is created when you run a Quick DRC or when you write a Custom Design Rule. You can define a name for the rule, a name for the AEL file, and where you want the file stored before you define the rule or you can save the rule after you create it. When you save a Design Rule, the program automatically updates the rule registry file to include the new rule (see “Rule Registry File” on page 1-2).

To save a design rule:

1. After defining a rule, click **Save As** in the Define Rule tab.

2. In the Save DRC Rule As dialog:
   - Select the **Rule Directory** (User or Project) where you want to save the rule.
   - Enter a **Rule Name** that describes the rule briefly.
   - In the **Rule File (.ael)** field, enter a name for the rule file, with a suffix .ael.

For details, refer to “Rule Directories” on page 1-3 and “Rule Registry File” on page 1-2.
Reloading DRC Results

When you run a DRC, you specify the job name to which the program saves the results of the check. Often a designer has several different design rule files for a given design. All the DRC run results are saved, so you can reload these results when required.

To reload DRC results:

1. In the DRC dialog, select **Load Result**.
2. Select the **Job Name** for the results you want to view.
3. Select **Apply** to display the results.
DRC Quick Start

**Viewing DRC Examples**

The Advanced Design System examples directory contains many DRC examples. Examples are constantly improved and new ones are added, so the files in your program may differ from what is shown here. However, the basic path is the same.

To view an example:

1. In the Advanced Design System Main window, select the Examples button on the toolbar.
2. In the File Browser, select the directory path to the example design. Figure 1-1 illustrates the path to the pwramp design:

examples/MW_Ckts/LNA_Prj/drc_via_prj/networks/pwramp.dsn

Figure 1-1. Selecting an Example Design
DRC Quick Start

**Copying a DRC Example**

The files in the examples directory are read-only, so you must copy them to your directory before you can run the examples.

To copy a DRC example:

1. In the Main window, select **File > Copy Project**.
2. In the Copy Project dialog box, select **Example Directory**.
3. Select **Browse**.
4. In the Copy From File Browse dialog box, double-click the project directory.
5. From the list of files in the selected project directory, select a project.
6. Click **OK**.
7. In the Copy Project dialog box, click **Startup Directory** as the To Project.
8. Click **Browse**.
9. In the Copy To File Browse dialog box, select the project directory, then click **OK**.
10. In the Copy Project dialog box, click at the end of the path displayed as the To Project and enter a file name (including suffix) for the copied project.
11. Confirm that Copy Project Hierarchy is selected.
12. Click **OK** to copy the project.
Chapter 2: Writing Design Rules

This chapter provides information for writing design rules. Design verification rules produce this information:

- Graphical data showing the location of each violation.
- An error message showing the nature of the violation.

A complete DRC example is included in this section. For detailed information on specific commands, see the command reference chapters.

Extension and Intrusion Definitions

The terms, Extension and Intrusion, used in creating design rules, are defined in the following illustration.
Anatomy of a Simple DRC Rule File

A DRC rule file is written in Application Extension Language (AEL). The illustration shows a simple DRC rule file. Typically, a rule file consists of a Layer section and a Rule section. The Layer section declares all the design layers used or checked and all the output DRC layers for displaying errors. The Rule section consists of rule checking statements.

```plaintext
// ael rule file: subvia.ael
// Purpose: To check Via to Via spacing rule
// declare input design layers
dcl backVia = dve_import_layer(20);
// declare output layer
dcl lyrDRCError = dve_export_layer(101);

// Substrate Via Spacing Design Rules
// Rule A - Substrate Via to Via minimum spacing 150 um
lyrDRCError += dve_drc(gap(backVia) < 150,
    "Substrate via edge to via edge min. is 150 um"
);
```

Note  A comment starts with a // or is enclosed by /* and */.
Layer Management

The rules file illustrated in this section analyzes data on the physical design layer cond. The width command checks the inside clearance distance between edges of the same polygon. Edges that are less than 3.0 layout units apart are exported as line segments to design layer error101. Each violation has an associated error message: width less than 3.0.

The AEL variable lyrCond references an import layer and the AEL variable lyrError101 references an export layer.

Import Layers

When performing a design rule check, you must specify the design layers you want checked for design violations. Design layers from your layout design are imported into the verification process using the command dve_import_layer.

You can specify an import layer by using a layer name or a layer number:

```
dcl lyrCond = dve_import_layer ("cond");
```

or

```
dcl lyrCond = dve_import_layer (1);
```
Import layers can be used only as input to a DRC command. An import layer must be an existing Physical design layer and can only be used for import (that is, it cannot appear again on the left-hand side of a rule command).

### Export Layers

Data is exported back to the layout editor by sending the output of the dve_drc command to an export layer. You create export layers using the command `dve_export_layer`.

You can specify an export layer by using a layer name or a layer number:

```c
decl lyrError101 = dve_export_layer ("error101");
```

or

---

2.4  Layer Management
decl lyrError101 = dve_export_layer (101);

An export layer must be an existing DRC design layer. The Design Rule Checker will not display DRC errors on a Physical layer.

When sending a DRC error to an export layer, the += assignment is used to signify that you are performing an append operation. Export layers are always empty at the beginning of each DRC invocation, so it is safe to use the += append assignment when sending data to an export layer.

Export layers cannot be used as input to a DRC command. Export layers can appear only on the left-hand side of a rule command.
Writing Design Rules

**Work Layers**

Work layers are used to reference intermediate data generated by a rule command. Work layers exist only temporarily while the DRC process is running, and are not part of the layout editor environment.

Use work layers when it is necessary to filter or process data on an import layer before generating a DRC error.

As good practice, you should always initialize a work layer to NULL.

**Rules File Layers Example**

This rules file example analyzes physical design data on layers cond and cond2. New polygons are created that represent the area where polygons on layer cond overlap polygons on layer cond2. The new polygons are placed in a work layer lyrPolyOverlap. The all_edges command identifies the entire polygon as an error and the data is exported to DRC layer error101.

```c
decl lyrCond = dve_import_layer ("cond");
dcl lyrCond2 = dve_import_layer ("cond2");
dcl lyrError101 = dve_export_layer ("error101");
dcl lyrPolyOverlap = NULL;
lyrPolyOverlap = dve_bool_and (lyrCond, lyrCond2);
lyrError101 += dve_drc (all_edges (lyrPolyOverlap),
                      "Conductive metal cond overlaps cond2");
```

**Complete DRC Example**

The example in this section illustrates writing design rules for Substrate Vias and NiCr Thin Film Resistors and manufacturing rules for Gate Metal. The example covers most of the functionalities and features of the DRC commands.

---

**Note** The DRC file used in this example is included in the drc_via_prj directory of the program's examples directory. For information on accessing the examples directory, see “Viewing DRC Examples” on page 1-14.

To set up a DRC check, you must define the design layers and the error layers. For information on setting up a DRC, refer to “Defining the Design Layers” on page 2-7 and “Defining the Error Layers” on page 2-8.
Table 2-1 shows the layer definitions for the process used in this example.

<table>
<thead>
<tr>
<th>Mask Level</th>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment Key</td>
<td>13</td>
<td>Defines fields in which alignment artifacts will be etched.</td>
</tr>
<tr>
<td>N+ Implant</td>
<td>2</td>
<td>Mask during alignment artifact etch, Implant mask for N+ regions.</td>
</tr>
<tr>
<td>D- Implant</td>
<td>1</td>
<td>Implant mask for DFET channels, Half DFET Diodes, D-Resistors.</td>
</tr>
<tr>
<td>NiCr</td>
<td>3</td>
<td>Lift off layer for NiCr Resistors</td>
</tr>
<tr>
<td>Ohmic</td>
<td>5</td>
<td>Liftoff layer for ohmic contact on GaAs devices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ohmic Metal may NOT be used for interconnect.</td>
</tr>
<tr>
<td>Isolation Implant</td>
<td>6</td>
<td>Implant mask for Isolation Implant</td>
</tr>
<tr>
<td>Gate Metal</td>
<td>7</td>
<td>Liftoff layer Schottky Gate/Anode contact on GaAs devices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gate Metal may NOT be used for interconnect</td>
</tr>
<tr>
<td>Metal 0</td>
<td>9</td>
<td>Liftoff layer for Metal 0</td>
</tr>
<tr>
<td>MIM</td>
<td>23</td>
<td>Liftoff layer for MIM metal</td>
</tr>
<tr>
<td>Via 1</td>
<td>14</td>
<td>First via etch layer</td>
</tr>
<tr>
<td>Metal 1</td>
<td>15</td>
<td>First plated Au metal layer. Labels are done in this layer</td>
</tr>
<tr>
<td>Air Bridge Post</td>
<td>10</td>
<td>Support Posts for Air Bridge and Via to Metal1</td>
</tr>
<tr>
<td>Air Bridge</td>
<td>11</td>
<td>Second plated Au metal layer</td>
</tr>
<tr>
<td>Passivation Via</td>
<td>12</td>
<td>Opens vias over bond pads and saw streets</td>
</tr>
<tr>
<td>Backside Via</td>
<td>20</td>
<td>Via holes (Via Option Only)</td>
</tr>
<tr>
<td>Backside Via Coat</td>
<td>21</td>
<td>Prevent solder wetting in vias (Via Option Only)</td>
</tr>
</tbody>
</table>

**Defining the Design Layers**

The rule section declares these imported design layers:

```c
// declare input design layers
decl nImplant = dve_import_layer(2);
decl nImplant = dve_import_layer(1);
decl niCr = dve_import_layer(3);
decl ohmic = dve_import_layer(5);
decl isoImplant = dve_import_layer(6);
decl gateMetal = dve_import_layer(7);
decl metal0 = dve_import_layer(9);
decl mIM = dve_import_layer(23);
```
Writing Design Rules

```c
decl via1 = dve_import_layer(14);
decl metal1 = dve_import_layer(15);
decl airBridgePost = dve_import_layer(10);
decl airBridge = dve_import_layer(11);
decl passVia = dve_import_layer(12);
decl backVia = dve_import_layer(20);
decl backViaCoat = dve_import_layer(21);
```

Although every layer is declared here, you do not need to declare a design layer if you will not be checking it. This example does not use all of these layers, because you are not checking the complete design.

Defining the Error Layers

After defining the design layers, declare three DRC error layers to display errors from a set of rules. When writing DRC rules, you decide how many DRC error layers are needed to best view the results of a check.

```c
// declare some DRC error layers
decl viaError = dve_export_layer(107); // for substrate via design rule
decl niCrError = dve_export_layer(103); // for thin film resistor rule
decl gateMetalError = dve_export_layer(120); // for gate metal rule
```

Checking the Clearance Rules

DRC checks clearance rules by selecting the edges that violate the clearance constraints and sending these to a DRC error layer. Clearance rules can be checked from either inside or outside of an edge to another edge of polygons. The types of clearance rules are: width, spacing, external, contains, nests, and internal. Of these, the simplest rule is width.
**width**

The `width` command is used to check the width of polygons on a given layer. The command checks the distance from the inside of one edge to the inside of another edge of the same polygon.

![Diagram of Backside Via and Gate Metal](image)

**Table 2-2. Substrates Via Design Rules**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum (um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Coded Substrate Via Feature, Square (layer 20)</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>Substrate Via Target (layer 7)</td>
<td>120</td>
</tr>
</tbody>
</table>

Width rules for the substrate via are written as follows:

```cpp
// Rule A: substrate via feature minimum 30 um
viaError += dve_drc(width(backVia) < 30,
    "Substrate via feature size < 30");

// Rule B: Substrate Via target size minimum 120 um
viaError += dve_drc(width(gateMetal) < 120,
    "Substrate via Target size < 120");
```
Writing Design Rules

**spacing**

The spacing command is used to check spacing constraints on a given layer. The command checks the distance from the outside of an edge to the outside of another edge.

```plaintext
// Substrate Via Spacing Design Rule
// Rule C - Substrate Via to Via minimum spacing 150 um
//

viaError += dve_drc(spacing(backVia) < 150, "Substrate via edge to via edge min. is 150 um");
```

Two other simple spacing rule commands are notch and gap. The notch command checks the spacing within the same polygon and the gap command checks the spacing between two different polygons. The spacing command checks both cases.

### Checking Clearance Between Layers

All the clearance commands mentioned to this point work only on polygons that are on the same layer. Next you will see clearance commands that check the clearance from one layer to another. The layers checked can be a design or work layer, so you can send a design layer to a work layer and perform a two-layer rule command with

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum (um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Substrate Via (layer 20) to Via (20), Edge to Edge</td>
<td>150</td>
</tr>
</tbody>
</table>
the original design layer. An example of this capability is shown in the “Using Rule Conjunction” on page 2-19.

**external**

The external command checks the external spacing between polygons on two different layers.

---

![Diagram of Backside Via (layer 20) to Iso. Implant (layer 6)](image)

---

**Table 2-4. Substrate Via Design Rule**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum(um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Substrate Via (layer 20) to Active Device Edge (layer 6)</td>
<td>90</td>
</tr>
</tbody>
</table>

```c
// Rule D - Substrate Via to Iso. Implant minimum spacing 90 um
//
viaError += dve_drc(external(backVia, isoImplant) < 90,
    "Substrate via edge to Iso. Implant Edge min. is 90 um");
```
contains

The contains command is used to check the inclusion of one polygon within another polygon. The command checks the distance from the inside edge of polygons on the first layer to the outside edge of polygons on the second layer.

```
// Rule E - Metal 0 Inclusion in Gate Metal min is 1 um

gateMetalError += dve_drc(contains(gateMetal, metal0) < 90,
    "Metal 0 Inclusion in Gate Metal min is 1 um");
```

Table 2-5. Substrate Via Design Rule

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum(um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Metal 0 (layer 9) Inclusion in Gate Metal (layer 7)</td>
<td>1.0</td>
</tr>
</tbody>
</table>
You can use the contains command to check the extension of one polygon outside another polygon on a different layer. The illustration uses this design rule on NiCr Thin Film Resistors.

```
// Rule F - Metal 0 Extension from NiCr  min is 0.5 um
niCrError += dve_drc(contains(metal0, niCr) < 0.5,
  "Metal 0 Extension from NiCr  min is 0.5 um",
  DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL);
```

The nests command checks the distance from the outside edge of polygons on the first layer to the inside edge of polygons on the second layer. It is exactly the same command as the contains command except the two layer arguments are switched.

The example writes the previous extension rule (Rule F) using the nests command.

```
// Rule F - Metal 0 Extension from NiCr  min is 0.5 um
niCrError += dve_drc(nests(niCr, metal0) < 0.5,
  "Metal 0 Extension from NiCr  min is 0.5 um",
  DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL);
```

Notice that a qualifier was used in Rule F. A qualifier is defined as a name-and-value-pair:

```
Qualifier_Name, Qualifier_Value
```

---

**Table 2-6. NiCr Thin Film Resistors Design Rule**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum(um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Metal 0 (layer 9) Extension from NiCr (layer 3)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

// Rule F - Metal 0 Extension from NiCr  min is 0.5 um
//
iCrError += dve_drc(contains(metal0, niCr) < 0.5,
  "Metal 0 Extension from NiCr  min is 0.5 um",
  DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL);
Clearance Rule Qualifiers filter in (or out) tests between pairs of edges for a rule step. If no qualifier is specified, a rule command normally checks all the edge pairs. However, in this example, we are interested only in the edge pairs that are parallel to each other. Without the Parallel qualifier, we would get an unpleasant surprise from errors caused by non-parallel edges as shown in the following figure. Remember, contains checks from outside of the first polygon (on NiCr) to the inside of the second polygon (on Metal 0).

A width command appears to work well without a qualifier. What happens to the adjacent edges? Actually, the width command has a default qualifier to filter out all the adjacent edges during the rule operation:

- DVE_RN_SEPARATE, DVE_RV_SEPARATE

Nearly all clearance commands have some type of default qualifiers to tell how the rule works. An example would be the Polarity qualifier. The fact that a command checks from the inside (or outside) of an edge to the inside (or outside) of another edge is dictated by the Polarity qualifier.

Two generic clearance commands (single_clearance and double_clearance) demand a polarity qualifier to tell them what to check. The single_clearance command is equivalent to a width command:

```plaintext
dve_drc(single_clearance(layer) < distance,
DVE_RN_POLARITY, DVE_RV_INSIDE);
```

The double_clearance command is equivalent to a contains command:

```plaintext
dve_drc(double_clearance(layer1, layer2) < distance,
DVE_RN_POLARITY_FROM, DVE_RV_INSIDE,
DVE_RN_POLARITY_TO, DVE_RV_OUTSIDE);
```

Details on the qualifiers for a given command are provided in the command reference chapters.
internal

This internal command checks the distance from the inside edge of one polygon to the inside edge of another polygon. The command is used to check the intrusion from one polygon into another polygon.

//
// NiCr Thin Film Design Rules
// Rule G - NiCr Intrusion into Metal 0  min is 2.5 um
//

niCrError += dve_drc(internal(niCr, metal0) < 2.5,
    "NiCr Intrusion into Metal0  min is 2.5 um");

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum(um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>NiCr (layer 3) Intrusion into Metal 0 (layer 9)</td>
<td>2.5</td>
</tr>
</tbody>
</table>
Writing Design Rules

Selecting Polygons

Several polygon selection commands are provided. In this example, only the `poly_path_length` and `poly_inter_layer` commands are described, but all polygon selection commands work similarly. For more details, see Chapter 4, Conditional Selection.

poly_path_length

The command `poly_path_length` selects polygons based on the path length property of overlapping polygons on two layers.

To check the width of a Thin Film Resistor, first do a boolean merge-NOT between the NiCr and Metal 0 layers to produce the resistor polygons. The path consisting of Bottom Inside Top (BIT) edges is the width of the resistor (see the illustration). Then select the bad resistors by checking the Bottom Inside Top (BIT) path length.

For details on determining the path code from merged polygons, refer to “Polygon Selection Based on Merge Properties” on page 4-42.

Table 2-8. NiCr Thin Film Resistors Design Rules

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum(um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Resistor (layer 3) Width</td>
<td>2.0</td>
</tr>
<tr>
<td>K</td>
<td>Resistor (layer 3) Length</td>
<td>3.0</td>
</tr>
</tbody>
</table>
In this rule example, you begin to use work layers. Also, the result of a poly_path_length command is a polygon layer, so you need an all_edges command to send the polygon layer to a DRC error layer for displaying.

```
// declare some work layers
decl lyrResistor, widthShort;

// NiCr Thin Film Design Rules
// Rule H - Resistor width min is 2um
// To produce the resistor polygons
lyrResistor = dve_bool_not(niCr, metal0);

// Select if the BIT path length is less than 2
widthShort = dve_drc(poly_path_length(lyrResistor) < 2,
    DVE_RN_PATH_CODE, DVE_RV_BIT, // set path code
    DVE_RN_PATH_LENGTH, DVE_RV_MIN_PATH // check minimum
);

// Attach error message & send error polygons to DRC error layer
NiCrError += dve_drc(all_edges(widthShort),
    "NiCr Thin Film Resistor min width 2.0 um"
);
```

The Rule K checks the length dimension of a resistor. It does not require a poly_path_length command, you can implement this rule by using a boolean command and a clearance command. Try this as an exercise.
Writing Design Rules

poly_inter_layer

The command poly_inter_layer selects polygon based on its relationship to another polygon. The command is very useful for selecting a subset of polygons out of a polygon layer and then performing a rule check on the subset.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum(um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Metal 0 (layer 9) Inclusion in Gate Metal (layer 7)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Go back to rule E, which was done previously without filtering out unwanted polygons before applying the clearance command. This rule catches many errors that occur outside of substrate vias because both the Metal 0 and Gate Metal layers are used in the construction of other devices (such as DFET). The clearance rule brings in all of the polygons from these two layers, including the polygons used for DFET.

Fortunately, you can tell when a Metal 0 or a Gate Metal polygon is used for a substrate via: it must enclose a polygon from the Backside Via layer (layer 20), as shown on the illustration. The poly_inter_layer command is used to select polygons like this. Here is the rewritten Rule E:

```
//
// Substrate Via Spacing Design Rules
// Rule E - Metal 0 Inclusion in Gate Metal min is 1 um
//
// declare some work layers

decl viaGateMetal,viaMetal0; // these are work layers,
```
// that do not map to a real
// process layer

// First, derive gate metal used for substrate vias by using
// only the gate metal that encloses the backside via layer
// viaGateMetal = dve_drc(poly_inter_layer(gateMetal, backVia),
// DVE_RN_INTER_CODE, DVE_RV_ENCLOSE_ONLY);
//
// In a similar way, derive the metal0 used for substrate vias
// viaMetal0 = dve_drc(poly_inter_layer(metal0, backVia),
// DVE_RN_INTER_CODE, DVE_RV_ENCLOSE_ONLY);
//
// Use contains cmd to check Inclusion between 2 work layers
// viaError += dve_drc(contains(viaGateMetal, viaMetal0) < 1,
// "Metal 0 Inclusion in Gate Metal min is 1 um");

You can use the poly_inter_layer to detect whether two polygon layers overlap in a
wrong manner. The command selects polygons by filtering in or out the overlapping
conditions, such as Inside, Outside, Touch, and Cut, and then sends the polygons
through an all_edges command to a DRC error layer. For more details, see
"poly_inter_layer()" on page 4-51.

Using Rule Conjunction

In general, the result of deriving a work layer from one rule command and later
feeding that work layer to another rule command is the combining of more than one
rule constraint. This is called rule conjunction. In fact, you have seen rule conjunction
in earlier examples of polygon selection commands. Here a more complicated example
shows how to use rule conjunction to check Gate Metal manufacturing rules.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Minimum (um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Gate Metal (layer 7) spacing when</td>
<td>Minimum (um)</td>
</tr>
<tr>
<td></td>
<td>width &lt; 1.5</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>1.5 &lt;= width &lt; 2.0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>2.0 &lt;= width &lt; 3.0</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>3.0 &lt;= width</td>
<td>3.0</td>
</tr>
</tbody>
</table>

// declare output layer
dcl gateMetalError = dve_export_layer(120);
Writing Design Rules

// Gate Metal spacing Rule
// Rule L - Min. spacing is
// 1.0 if width < 1.5
// 1.5 if 1.5 <= width < 2.0
// 2.0 if 2.0 <= width < 3.0
// 3.0 if width >= 3.0

// declare some work layers
decl gatMet15Lt, gatMet15Ge, gatMet20Lt, gatMet20Ge;
decl gatMet30Lt, gatMet30Ge;

// Rule: Min. spacing is 1.0  if width < 1.5
// 1. select the edges with width < 1.5 from gateMetal, save in
//    gatMet15Lt
// 2. select the edges with spacing error by checking the distance
//    between gateMetal and gatMet15Lt

gatMet15Lt = dve_drc(width(gateMetal) < 1.5);
gateMetalError += dve_drc(external(gateMetal, gatMet15Lt) < 1.0,
   "Gate Metal min spacing 1.0um when its width < 1.5um");

// Rule: Min. spacing is 1.5  if  1.5 <= width < 2.0
// 1. select the edges with width >= 1.5 from gateMetal, save in
//    gatMet15Ge
// 2. select the edges with width < 2.0 from gatMet15Ge, save in
//    fateMet20Lt
// 3. select the edges with spacing error by checking the distance
//    between gateMetal and gatMet20Lt

gatMet15Ge = dve_drc(width(gateMetal) >= 1.5);
gatMet20Lt = dve_drc(width(gatMet15Ge) < 2.0);
gateMetalError += dve_drc(external(gateMetal, gatMet20Lt) < 1.5,
   "Gate Metal min spacing 1.5um when its width within [1.5, 2)");

// Rule: Min. spacing is 2.0  if 2.0 <= width < 3.0

gatMet20Ge = dve_drc(width(gateMetal) >= 2.0);
gatMet30Lt = dve_drc(width(gatMet20Ge) < 3.0);
gateMetalError += dve_drc(external(gateMetal, gatMet30Lt) < 2.0,
   "Gate Metal min spacing 2.0um when its width within [2.0, 3)");

// Rule: Min. spacing is 3.0  if width >= 3.0

gatMet30Ge = dve_drc(width(gateMetal) >= 3.0);
gateMetalError += dve_drc(external(gateMetal, gatMet30Ge) < 3.0,
   "Gate Metal min spacing 3.0um when its width > 3.0 um");

Congratulations. You have finished writing your first rule file. If you would like to
save it to a file, remember to use the file extension .ael. For details, see “Saving a
DRC Rule” on page 1-12.
Writing Design Rules
Chapter 3: DRC Layer Management Commands

This section describes the DRC Layer Management commands used to import and export layers.

**dve_import_layer()**
Used to get design data from the layout editor into the design verification process. Copies layer data from the layout editor onto an import layer that can be used in a rule command. Returns an import layer.
See also: dve_export_layer

Syntax
```
inputLayer = dve_import_layer (layerId);
```
where:
layerId is the string layer name or integer layer number of an existing design layer

Example
```
decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");
lyrError101 += dve_drc (width (lyrCond) < 4.0, 
    "Metal width less than 4.0");
```

**dve_export_layer()**
Used to export DRC error information. Data written to an export layer will be directly exported back to the layout editor. Returns an export layer.
See also: dve_import_layer

Syntax
```
exportLayer = dve_export_layer (layerId);
```
where:
layerId is the string name or integer layer number of an existing design layer

Example
```
// Import layers
```
DRC Layer Management Commands

```c
decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");

// Export layers
decl lyrError101 = dve_export_layer ("error101");
decl lyrError102 = dve_export_layer ("error102");

// Work layer
decl lyrOverlap = NULL;

// Export DRC error directly to an export layer
lyrError101 += dve_drc (width (lyrCond) < 4.0,
   "Metal width less than 4.0");
lyrOverlap = dve_bool_and (lyrCond, lyrCond2);
lyrError102 += dve_drc (all_edges (lyrOverlap),
   "Metal layers overlap");
```
Chapter 4: Conditional Selection

This section describes the DRC command used for conditional selection.

**dve_drc()**

Used to select edges and polygons conditionally based upon intrinsic properties and information derived during an operation on one or more layers. Returns: a layer containing selected edge segments.

**Syntax**

```
dve_drc (drc_expression [, msgString][, qualifierName, qualifierValue]);
```

where:

- **drc_expression** is an AEL expression in the format:
  ```
  drc_subfunction ([parameter, ...]) [operator rValue])
  ```
- **drc_subfunction** is a selection function to be performed on the polygons or edges on a given layer. Edges and polygons that meet the criteria are selected and copied to the output layer. The subfunctions are:
  - Edge Selection Based On Clearance (output layer contains polygons with selected edges) selection functions include: contains, double_clearance, external, gap, internal, nests, notch, single_clearance, spacing, width
  - Edge Selection By Select All or Inversion selection functions include: all_edges, invert_edges
  - Edge Selection Based on Corners selection functions include: corner_edges
  - Edge Selection Based on Grid selection functions include: off_grid
  - Edge Compensation selection functions include: compensate
  - Polygon Selection Based on Intrinsic Properties (output layer contains polygons) selection functions include: poly_area, poly_hole_count, poly_line_length, poly_perimeter
  - Polygon Selection Based on Merge Properties (output layer contains polygons) selection functions include: poly_edge_code, poly_path_count, poly_path_length
  - Polygon Selection Based on Edge Relationships (output layer contains polygons) selection functions include: poly_inter_layer

**parameter** A parameter to a dve_drc subfunction command.
Conditional Selection

Operator function  A relational function that is applied to the value returned from the dve_drc function. A relational function includes these operators:

\[
\begin{align*}
< & \quad \text{Less than} \\
\leq & \quad \text{Less than or equal to} \\
= & \quad \text{Equal to} \\
> & \quad \text{Greater than} \\
\geq & \quad \text{Greater than or equal to}
\end{align*}
\]

rValue  A real or integer value that depends upon the DRC subfunction.

msgString  A string that will be attached to the selected edges. Only pertains to selected edges. Can only be used in conjunction with the export nomenclature (such as, “+=”).

qualifierName  A constant that represents the name of the qualifier. Qualifiers are documented for each dve_drc subfunction.

qualifierValue  A value that will be applied to the named qualifier. Valid range of values are documented for each dve_drc subfunction.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (width (lyrCond) < 3.0,
    "Width of conductive metal < 3.0");
Edge Selection Based On Clearance

The Edge Selection Based On Clearance selection functions are used where the output layer contains polygons with selected edges. These functions include: contains, double_clearance, external, gap, internal, nests, notch, single_clearance, spacing, width.

contains()

A DRC function to measure enclosure distance from the outside of the contained polygon to the inside of the containing polygon.

Syntax

dve_drc (contains (inLayer1, inLayer2) operator distance [, msgString] [, qualifierName, qualifierValue...]);

where:

inLayer1  Contained polygon layer.
inLayer2  Containing polygon layer.
operator  
<  Less than
<=  Less than or equal to
==  Equal to
>  Greater than
>=  Greater than or equal to
distance  A distance value in layout units.
msgString  A string value that will be attached to the selected error segments.
qualifierName, qualifierValue  A name, value pair that qualifies the selection.

Edge Qualifiers

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:

DVE_RV_PARALLEL  Select only parallel edges.
Conditional Selection

DVE_RV_NOT_PARALLEL   Select only non-parallel edges.
DVE_RV_PERPENDICULAR   Select only perpendicular edges.
DVE_RV_NOT_PERPENDICULAR   Select only non-perpendicular edges.
DVE_RV_ANY_ANGLE        (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualifier Resource Value:

<real value>   Edge angle tolerance in degrees.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (contains (lyrCond, lyrCond2) < 3.0,
"Enclosure clearance < 3.0");

double_clearance()

Measures the distance between edges of polygons on different layers.
See also: dve_drc

Syntax

dve_drc (double_clearance (inLayer1, inLayer2) operator distance
[, msgString] [,qualifierName, qualifierValue..]);

where:

inLayer1, inLayer2   A polygon or edge layer.
operator

<   Less than
\leq   Less than or equal to
==   Equal to
>   Greater than
\geq   Greater than or equal to

4.4   Edge Selection Based On Clearance
distance  A value in layout units.
msgString  A string value that will be attached to the selected error segments.
qualifierName, qualifierValue  A name, value pair that qualifies the selection.

**Edge Qualifiers**

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:
- DVE_RV_PARALLEL  Select only parallel edges.
- DVE_RV_NOT_PARALLEL  Select only non-parallel edges.
- DVE_RV_PERPENDICULAR  Select only perpendicular edges.
- DVE_RV_NOT_PERPENDICULAR  Select only non-perpendicular edges.
- DVE_RV_ANY_ANGLE  (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualifier Resource Value:
- <real value>  Edge angle tolerance in degrees.

Qualifier Resource Name: DVE_RN_POLARITY, DVE_RN_POLARITY_FROM, DVE_RN_POLARITY_TO

Qualifier Resource Value:
- DVE_RV_INSIDE  Direct search toward inside of polygon
- DVE_RV_OUTSIDE  (default)  Direct search toward outside of polygon

Qualifier Resource Name: DVE_RN_TEMPLATE, DVE_RN_TEMPLATE_FROM, DVE_RN_TEMPLATE_TO

Qualifier Resource Value:
- DVE_RV_ARC  Extend search area using arced corners.
- DVE_RV_BOTHSIDES  Extend search area on both sides of edge.
- DVE_RV_OPPOSITE  (Default) Extend search area just opposite the edge.
- DVE_RV_ROUND  Extend search area using rounded corners.
- DVE_RV_SQUARE  Extend search area treating corners as squares.

**Example**
Conditional Selection

```c
decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (double_clearance (lyrCond, lyrCond2) < 3.0,
"Metal layers run parallel and close",
DVE_RN_POLARITY, DVE_RV_OUTSIDE,
DVE_RN_TEMPLATE, DVE_RV_OPPOSITE,
DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL,
DVE_RN_ANGLE_TOLERANCE, 1.2);
```

**external()**

Measures the distance between outside edges of polygons of different layers.

See also: dve_drc

**Syntax**

```c
dve_drc (external (inLayer1, inLayer2) operator distance [, msgString] [, qualifierName, qualifierValue...]);
```

where:

- **inLayer1, inLayer2** A polygon layer
- **operator**
  - `<` Less than
  - `<=` Less than or equal to
  - `==` Equal to
  - `>` Greater than
  - `>=` Greater than or equal to
- **distance** A distance value in layout units.
- **msgString** A string value that will be attached to the selected error segments.
- **qualifierName, qualifierValue** A name, value pair that qualifies the selection.

**Edge Qualifiers**

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:

- **DVE_RV_PARALLEL** Select only parallel edges.
DVE_RV_NOT_PARALLEL  Select only non-parallel edges.
DVE_RV_PERPENDICULAR  Select only perpendicular edges.
DVE_RV_NOT_PERPENDICULAR  Select only non-perpendicular edges.
DVE_RV_ANY_ANGLE  (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE
Qualifier Resource Value:
<real value>  Edge angle tolerance in degrees.

Example

dcl lyrCond = dve_import_layer ("cond");
dcl lyrCond2 = dve_import_layer ("cond2");
dcl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (external (lyrCond, lyrCond2) < 4.0,
  "Outside edges of metal layers < 4.0",
  DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL);

gap()
Measures the distance between outside edges of different polygons of the same layer.
See also: dve_drc

Syntax

dve_drc (gap (inLayer) operator distance [, msgString]
  [, qualifierName, qualifierValue...]);

where:
inLayer  A polygon or edge layer.
operator
  <  Less than
  <=  Less than or equal to
  ==  Equal to
  >  Greater than
  >=  Greater than or equal to
Conditional Selection

- **distance**  A distance value in layout units.
- **msgString**  A string value that will be attached to the selected error segments.
- **qualifierName, qualifierValue**  A name, value pair that qualifies the selection.

**Edge Qualifiers**

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualified Resource Value:
- DVE_RV_PARALLEL  Select only parallel edges.
- DVE_RV_NOT_PARALLEL  Select only non-parallel edges.
- DVE_RV_PERPENDICULAR  Select only perpendicular edges.
- DVE_RV_NOT_PERPENDICULAR  Select only non-perpendicular edges.
- DVE_RV_ANY_ANGLE  (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualified Resource Value:
- <real value>  Edge angle tolerance in degrees.

**Example**

```dve
decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");

// Check between outside edges of polygons on same layer
lyrError101 += dve_drc (gap (lyrCond) < 4.0, "Outside edges < 4.0");
```

**internal()**

Measures clearance from the inside of one edge of a polygon to the inside of another edge of a different polygon.

See also: dve_drc

**Syntax**

```dve
dve_drc (internal (inLayer1, inLayer2) operator distance [, msgString] [, qualifierName, qualifierValue...]);
```

where:
- **inLayer1, inLayer2**  A polygon layer.
operator

<  Less than
<= Less than or equal to
== Equal to
>  Greater than
>= Greater than or equal to

distance  A distance value in layout units.

msgString  A string value that will be attached to the selected error segments.

qualifierName, qualifierValue  A name, value pair that qualifies the selection.

Edge Qualifiers

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:

DVE_RV_PARALLEL  Select only parallel edges.
DVE_RV_NOT_PARALLEL  Select only non-parallel edges.
DVE_RV_PERPENDICULAR  Select only perpendicular edges.
DVE_RV_NOT_PERPENDICULAR  Select only non-perpendicular edges.
DVE_RV_ANY_ANGLE  (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualifier Resource Value:

<real value>  Edge angle tolerance in degrees.

Example

dcl lyrCond = dve_import_layer ("cond");
dcl lyrCond2 = dve_import_layer ("cond2");
dcl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (internal (lyrCond, lyrCond2) < 4.0,
"Inside edges < 4.0");
Conditional Selection

nests()

Measures enclosure distance from the outside of the contained polygon to the inside of the containing polygon.

See also: dve_drc

Syntax

dve_drc (nests (inLayer1, inLayer2) operator distance [, msgString] [,qualifierName, qualifierValue...]);

where:

- inLayer1   The contained polygon layer.
- inLayer2   The containing polygon layer.
- operator   distance   A distance value in layout units.
- msgString  A string value that will be attached to the selected error segments.
- qualifierName, qualifierValue  A name, value pair that qualifies the selection.

Edge Qualifiers

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:

<table>
<thead>
<tr>
<th>Qualifier Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVE_RV_PARALLEL</td>
<td>Select only parallel edges.</td>
</tr>
<tr>
<td>DVE_RV_NOT_PARALLEL</td>
<td>Select only non-parallel edges.</td>
</tr>
<tr>
<td>DVE_RV_PERPENDICULAR</td>
<td>Select only perpendicular edges.</td>
</tr>
<tr>
<td>DVE_RV_NOT_PERPENDICULAR</td>
<td>Select only non-perpendicular edges.</td>
</tr>
<tr>
<td>DVE_RV_ANY_ANGLE</td>
<td>(default) Select edges at any angle.</td>
</tr>
</tbody>
</table>
Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualifier Resource Value:

<real value>  Edge angle tolerance in degrees.

Example

```c
decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");
decl lyrError102 = dve_export_layer ("error102");

lyrError101 += dve_drc (nests (lyrCond, lyrCond2) < 4.0,
   "Clearance from contained to containing layers < 4.0");
lyrError102 += dve_drc (nests (lyrCond2, lyrCond) < 4.0,
   "Clearance from contained to containing layers < 4.0");
```

**notch()**

Measures the distance between outside edges of the same polygon on the given layer.

See also: dve_drc

**Syntax**

```c
dve_drc (notch (inLayer) operator distance [, msgString]
   [,qualifierName, qualifierValue...]);
```

where:

- **inLayer**  A polygon layer.
- **operator**
  - `<`  Less than
  - `<=`  Less than or equal to
  - `==`  Equal to
  - `>`  Greater than
  - `>=`  Greater than or equal to
- **distance**  A distance value in layout units.
- **msgString**  A string value that will be attached to the selected error segments.
- **qualifierName, qualifierValue**  A name, value pair that qualifies the selection.
Conditional Selection

**Edge Qualifiers**

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:

- DVE_RV_PARALLEL  Select only parallel edges.
- DVE_RV_NOT_PARALLEL  Select only non-parallel edges.
- DVE_RV_PERPENDICULAR  Select only perpendicular edges.
- DVE_RV_NOT_PERPENDICULAR  Select only non-perpendicular edges.
- DVE_RV_ANY_ANGLE (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualifier Resource Value:

<real value>  Edge angle tolerance in degrees.

**Example**

```c
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (notch (lyrCond2) < 15.0, "Outside edges same polygon < 15.0");
```

**single_clearance()**

Measures the distance between edges of a single polygon.

See also: dve_drc

**Syntax**

dve_drc (single_clearance (inLayer) operator distance [, msgString] [, qualifierName, qualifierValue...]);

where:

- inLayer  A polygon or edge layer.
- operator

  - <  Less than
  - <= Less than or equal to
distance  A distance value in layout units.
msgString  A string value that will be attached to the selected error segments.
qualifierName, qualifierValue  A name, value pair that qualifies the selection.

**Edge Qualifiers**

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:

- DVE_RV_PARALLEL  Select only parallel edges.
- DVE_RV_NOT_PARALLEL  Select only non-parallel edges.
- DVE_RV_PERPENDICULAR  Select only perpendicular edges.
- DVE_RV_NOT_PERPENDICULAR  Select only non-perpendicular edges.
- DVE_RV_ANY_ANGLE  (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualifier Resource Value:

<real value>  Edge angle tolerance in degrees.

Qualifier Resource Name:

DVE_RN_POLARITY
DVE_RN_POLARITY_FROM
DVE_RN_POLARITY_TO

Qualifier Resource Value:

- DVE_RV_INSIDE  Direct search toward inside of polygon
- DVE_RV_OUTSIDE  (default) Direct search toward outside of polygon

Qualifier Resource Name:

DVE_RN_TEMPLATE
DVE_RN_TEMPLATE_FROM
DVE_RN_TEMPLATE_TO

==  Equal to
>  Greater than
>=  Greater than or equal to
Conditional Selection

Qualifier Resource Value:
- DVE_RV_ARC  Extend search area using arced corners.
- DVE_RV_BOTHSIDES  Extend search area on both sides of edge.
- DVE_RV_OPPOSITE  (Default) Extend search area just opposite the edge.
- DVE_RV_ROUND  Extend search area using rounded corners.
- DVE_RV_SQUARE  Extend search area treating corners as squares.

Qualifier Resource Name: DVE_RN_STRUCTURE

Qualifier Resource Value:
- DVE_RV_ANY_POLYGON  (Default) Test applies to any edge.
- DVE_RV_SAME_POLYGON  Test applies only between edges of same polygon.
- DVE_RV_DIFF_POLYGON  Test applies only between edges of different polygons.

Example

dcl lyrCond = dve_import_layer ("cond");
dcl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (single_clearance (lyrCond) < 3.0,
  "Parallel clearance < 3.0",
  DVE_RN_POLARITY, DVE_RV_OUTSIDE,
  DVE_RN_TEMPLATE, DVE_RV_OPPOSITE,
  DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL,
  DVE_RN_ANGLE_TOLERANCE, 1.2);

spacing()
Simultaneously measures the distance between outside edges of different polygons of the same layer (gap) and outside edges of the same polygon (notch).

See also: dve_drc

Syntax

dve_drc (spacing (inLayer) operator distance [, msgString]
  [, qualifierName, qualifierValue...]);

where:
inLayer  A polygon layer.
operator

< Less than
\leq Less than or equal to
\leq Equal to
> Greater than
\geq Greater than or equal to

distance  A distance value in layout units

msgString  A string value that will be attached to the selected error segments

qualifierName, qualifierValue  A name, value pair that qualifies the selection

**Edge Qualifiers**

Qualifier Resource Name: DVE_RN_EDGE_ANGLES

Qualifier Resource Value:

DVE_RV_PARALLEL  Select only parallel edges.
DVE_RV_NOT_PARALLEL  Select only non-parallel edges.
DVE_RV_PERPENDICULAR  Select only perpendicular edges.
DVE_RV_NOT_PERPENDICULAR  Select only non-perpendicular edges.
DVE_RV_ANY_ANGLE  (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

Qualifier Resource Value:

<real value>  Edge angle tolerance in degrees.

**Example**

decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (spacing (lyrCond2) < 15.0,
    "Gap and notch spacing < 15.0");
Conditional Selection

width()
A DRC clearance function to check from the inside of one edge of a polygon to the inside of another edge of the same polygon.
See also: dve_drc

Syntax

dve_drc (width (inLayer) operator distance [, msgString] [, qualifierName, qualifierValue, ...]);

where:
- inLayer: A polygon layer.
- operator: 
  - <: Less than
  - <=: Less than or equal to
  - ==: Equal to
  - >: Greater than
  - >=: Greater than or equal to
- distance: A distance value in layout units
- msgString: A string value that will be attached to the selected error segments
- qualifierName, qualifierValue: A name, value pair that qualifies the selection

Edge Qualifiers
Qualifier Resource Name: DVE_RN_EDGE_ANGLES
Qualifier Resource Value:
- DVE_RV_PARALLEL: Select only parallel edges.
- DVE_RV_NOT_PARALLEL: Select only non-parallel edges.
- DVE_RV_PERPENDICULAR: Select only perpendicular edges.
- DVE_RV_NOT_PERPENDICULAR: Select only non-perpendicular edges.
- DVE_RV_ANY_ANGLE: (default) Select edges at any angle.

Qualifier Resource Name: DVE_RN_ANGLE_TOLERANCE

4-16 Edge Selection Based On Clearance
Qualifier Resource Value:

<real value>  Edge angle tolerance in degrees.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (width (lyrCond) < 3.0,
  "Width of metal layer < 3.0");
Conditional Selection

**Edge Selection By Select All or Inversion**

Edge Selection By Select All or Inversion selection functions include: `all_edges`, `invert_edges`.

**all_edges()**
Sends all the edge segments of polygons of a layer to an output error layer.

See also: `dve_drc`

**Syntax**

```
dve_drc (all_edges (inLayer) [, msgString]);
```

where:

- `inLayer` A polygon layer.
- `msgString` A string value that will be attached to the selected error segments

**Example**

```
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");
decl lyrWork = NULL;

lyrWork = dve_drc (poly_area (lyrCond2) < 10.0);

lyrError101 += dve_drc (all_edges (lyrWork),
                        "Conductive metal area < 10.0")
```

**invert_edges()**
Deselects selected edges and simultaneously selects unselected edges.

See also: `dve_drc`

**Syntax**

```
dve_drc (invert_edges (inLayer) [, msgString]);
```

where:

- `inLayer` A layer with selected edge segments.
- `msgString` A string value that will be attached to the selected error segments

**Example**

```
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");
decl lyrWork = NULL;

lyrWork = dve_drc (poly_area (lyrCond2) < 10.0);

lyrError101 += dve_drc (invert_edges (lyrWork),
                      "Conductive metal area < 10.0")
```
decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");
decl lyrEdgesGap = NULL;
decl lyrEdgesInvert = NULL;
decl lyrEdges = NULL;
decl lyrPoly = NULL;

lyrEdgesGap = dve_drc (single_clearance (lyrCond) <= 3.0,
    DVE_RN_POLARITY, DVE_RV_OUTSIDE,
    DVE_RN_TEMPLATE, DVE_RV_OPPOSITE,
    DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL,
    DVE_RN_STRUCTURE, DVE_RV_DIFF_POLYGON,
    DVE_RN_ANGLE_TOLERANCE, 1.2);

lyrEdgesInvert = dve_drc (invert_edges (lyrEdgesGap));

lyrEdges = dve_drc (double_clearance (lyrEdgesGap, lyrEdgesInvert) < 3.0,
    DVE_RN_POLARITY, DVE_RV_INSIDE,
    DVE_RN_TEMPLATE, DVE_RV_OPPOSITE,
    DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL,
    DVE_RN_ANGLE_TOLERANCE, 1.2, "par");

lyrPoly = dve_quadout (lyrEdges);

lyrError101 = dve_drc (all_edges (lyrPoly),
    "Parallel interconnect < 3.0");
Conditional Selection

**Edge Selection Based on Corners**

Edge Selection Based on Corners selection function includes: corner_edges.

**corner_edges()**

Generates error segments around corners of specified angles.

See also: dve_drc

**Syntax**

```c
dve_drc (corner_edges (inLayer, segmentLength, beginningAngle, endingAngle) [,msgString]);
```

where:

- `inLayer` A polygon layer.
- `segmentLength` A real value in layout units that represents the length of the error segment that will be drawn around the corner.
- `beginningAngle` A real value that represents the minimum angle that will be selected
- `endingAngle` A real value that represents the max angle that will be selected
- `msgString` A string value that will be attached to the selected error segments

**Example**

```c
decl lyrCond = dve_import_layer ("cond");
dcl lyrError101 = dve_export_layer ("error101");
dcl lyrEdgesCvex = NULL;
dcl lyrEdgesStub = NULL;
dcl lyrStub = NULL;
lyrEdgesCvex = dve_drc (corner_edges (lyrCond, 0.5, 1, 91));
lyrEdgesStub = dve_drc (single_clearance (lyrEdgesCvex) < 3.0,
                        DVE_RN_POLARITY, DVE_RV_INSIDE,
                        DVE_RN_TEMPLATE, DVE_RV_OPPOSITE,
                        DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL,
                        DVE_RN_STRUCTURE, DVE_RV_SAME_POLYGON);
lyrStub = dve_quadout (lyrEdgesStub);
lyrError101 += dve_drc (all_edges (lyrStub), "Stub");
```

4-20  Edge Selection Based on Corners
Edge Selection Based on Grid

Edge Selection Based on Grid selection function includes: off_grid.

off_grid()
Flags edges whose end points fall off a specified grid.
See also: dve_drc

Syntax

dve_drc (off_grid (inLayer, grid) [,msgString]);

where:

inLayer  A polygon layer.
grid     A specified grid.
msgString A string value that will be attached to the selected error segments

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");

lyrError101 += dve_drc (off_grid (lyrCond, 0.5),
              "Conductive metal is off grid");
Conditional Selection

### Edge Compensation

Edge Compensation selection function includes: `compensate`

**compensate()**

Moves error segments on a given layer by a given distance. Output layer can only be used as input to `dve_quadout` and `dve_plgout` commands. Returns: A layer with selected edge segments.

See also: `dve_quadout`, `dve_plgout`

**Syntax**

```plaintext
edgeLayerOut = dve_compensate (edgeLayerIn, distance [,resourceName, resourceValue]);
```

where:

- `edgeLayerIn, edgeLayerOut` An edge layer.
- `distance` A real value.

**Compensate Template Qualifier**

Qualifier Resource Name: DVE_RN_COMP_TEMPLATE

<table>
<thead>
<tr>
<th>Qualifier Resource Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVE_RV_CHAMFER</td>
<td>Compensate using an angle from the orthogonal.</td>
</tr>
<tr>
<td>DVE_RV_ALIGN</td>
<td>(Default) Compensate using an alignment to the adjacent edge.</td>
</tr>
<tr>
<td>DVE_RV_BISECT</td>
<td>Compensate where the angle is bisected at the corner.</td>
</tr>
<tr>
<td>DVE_RV_OPPOSITE</td>
<td>Compensate directly opposite the edge.</td>
</tr>
</tbody>
</table>

Qualifier Resource Name: DVE_RN_CHAMFER_ANGLE

<table>
<thead>
<tr>
<th>Qualifier Resource Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;real value&gt;</td>
<td>Edge angle offset in degrees.</td>
</tr>
</tbody>
</table>

**Example**

```plaintext
decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");
decl lyrEdges = NULL;
decl lyrEdgesComp = NULL;
```
decl lyrPolyCond = NULL;
decl lyrPolyComp = NULL;
decl lyrPolyOversize = NULL;

// Generate an oversized polygon
lyrEdges = dve_drc (width (lyrCond) < 5.0);
lyrEdgesComp = dve_drc (compensate (lyrEdges, 0.5),
                      DVE_RN_COMP_TEMPLATE, DVE_RV_CHAMFER,
                      DVE_RN_CHAMFER_ANGLE, 45);
lyrPolyCond = dve_quadout (lyrEdges);
lyrPolyComp = dve_quadout (lyrEdgesComp);
lyrPolyOversize = dve_bool_or (lyrPolyCond, lyrPolyComp);

// Check gap clearance
lyrError101 += dve_drc (gap (lyrPolyOversize) < 4.0, "Gap clearance < 4.0");
Conditional Selection

**Polygon Selection Based on Intrinsic Properties**

Polygon Selection Based on Intrinsic Properties (output layer contains polygons) selection functions include: `poly_area`, `poly_hole_count`, `poly_line_length`, `poly_perimeter`.

`poly_area()`

Selects polygons based upon area. Returns: A polygon layer.

See also: `dve_drc`

**Syntax**

```c
dve_drc (poly_area (inLayer) operator value);
```

where:

- `inLayer` A polygon layer.
- `operator` A real value in layout units.

**Example**

```c
decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");

decl lyrPoly = NULL;

lyrPoly = dve_drc (poly_area (lyrCond) < 15.0);

lyrError101 += dve_drc (all_edges (lyrPoly), "Polygon area < 15.0");
```

`poly_hole_count()`

Selects polygons based upon the number of holes. Returns: A polygon layer.
See also: dve_drc

Syntax

dve_drc (poly_hole_count (inLayer) operator numHoles);

where:

inLayer A polygon layer.

operator

< Less than

<= Less than or equal to

== Equal to

> Greater than

>= Greater than or equal to

numHoles An integer value representing the number of holes

Example

dcl lyrCond = dve_import_layer ("cond");
dcl lyrCond2 = dve_import_layer ("cond2");
dcl lyrError101 = dve_export_layer ("error101");

dcl lyrPoly = NULL;
dcl lyrPolyHole = NULL;

lyrPoly = dve_bool_not (lyrCond, lyrCond2);
lyrPolyHole = dve_drc (poly_hole_count (lyrPoly) >= 1);
lyrError101 += dve_drc (all_edges (lyrPolyHole), "Polygon contains holes");

poly_line_length()

Selects polygons based upon the minimum line length. Returns: A polygon layer.
See also: dve_drc

Syntax

dve_drc (poly_line_length (inLayer) operator distance [, qualifierName, qualifierValue]);
Conditional Selection

where:

inLayer A polygon layer.

operator

< Less than
<= Less than or equal to
== Equal to
> Greater than
>= Greater than or equal to

value An real value in layout units

qualifierName qualifierValue A name-value pair that qualifies the rule

Line Length Resource Qualifiers
Qualifier Resource Name: DVE_RN_LINE_LENGTH
Qualifier Resource Value

DVE_RV_MIN_LINE (Default) Select based upon minimum line length of polygon.
DVE_RV_MAX_LINE Select based upon maximum line length of polygon.

Example

dcl lyrCond = dve_import_layer ("cond");
dcl lyrError101 = dve_export_layer ("error101");

dcl lyrPoly = NULL;

lyrPoly = dve_drc (poly_line_length (lyrCond) <= 10.0,
DVE_RN_LINE_LENGTH, DVE_RV_MAX_LINE);

lyrError101 += dve_drc (all_edges (lyrPoly), "Polygon length < 10.0");

poly_perimeter()
Selects polygons based upon the total length of the outside edges. Returns: A polygon layer.

See also: dve_drc
Syntax

dve_drc (poly_perimeter (inLayer) operator distance);

where:

- `inLayer` A polygon layer.
- `operator`  
  - `<` Less than
  - `<=` Less than or equal to
  - `==` Equal to
  - `>` Greater than
  - `>=` Greater than or equal to
- `distance` A real value in layout units.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrError101 = dve_export_layer ("error101");

decl lyrPoly = NULL;

lyrPoly = dve_drc (poly_perimeter (lyrCond) < 20.0);

lyrError101 += dve_drc (all_edges (lyrPoly), "Polygon perimeter < 20.0");
Polygon Selection Based on Merge Properties

Polygon Selection Based on Merge Properties selection functions include:
poly_edge_code, poly_path_count, and poly_path_length.

Polygon merge qualifier commands constrain the selection of edges based upon a
specified edge code. All of the commands in this section are based upon edge
information computed during a merge operation.

When polygon TOP and polygon BOTTOM merges, a set of vertices (shown as ‘*’)
consisting of the intersection points is derived. Each resultant edge between pairs of
these vertices has a unique ‘edge_code’ that describe its relationship to other edges.

where:

TOP_OUTSIDE_BOTTOM (T) is the polygon TOP outside polygon BOTTOM.
BOTTOM_OUTSIDE_TOP (B) is the polygon BOT outside polygon TOP.
TOP_INSIDE_BOTTOM (t) is the polygon TOP inside polygon BOTTOM.
BOTTOM_INSIDE_TOP (b) is the polygon BOT inside polygon BOTTOM.
INTERNAL (I) is the edges of TOP and BOTTOM butting internally.
EXTERNAL (E) is the edges of TOP and BOTTOM butting externally.

Path Code Qualifiers

Qualifier Resource Name: DVE_RN_PATH_CODE

Qualifier Resource Value:

TTTTTTTTTTTTT  polygon TOP
T  T
*bbbbbBBBBBBB  polygon BOTTOM
I  t  B
I  t  B
*bbbbbBBBBBB  B
T  T  B  B
T  T  B  B
T  T  B  B
T  T  B  B
T  T  B  B
T  B  B  B
T  E  B
T  E  B
T  B  B  B
T  T
TTTTTTTTTTTT

4.28  Polygon Selection Based on Merge Properties
DVE_RV_TOP  (Default) Select edges on top that are outside bottom.
DVE_RV_BOT  Select edges on bottom that are outside top.
DVE_RV_TIB  Select edges on top that are inside bottom.
DVE_RV_BIT  Select edges on bottom that are inside top.
DVE_RV_INT  Select edges on top and bottom that are butting internally.
DVE_RV_EXT  Select edges on top and bottom that are butting externally.

dve_drc (poly_edge_code (inLayer) [,qualifierName,qualifierValue]);
where:
inLayer  A polygon layer produced by a merge operation between two layers.
qualifierName, qualifierValue  A name, value pair that qualifies the selection.

Selection Qualifier
Qualifier Resource Name: DVE_RN_SELECT
Qualifier Resource Value
  DVE_RV_ACCEPT_ANY  Select polygon if any path codes are found.
  DVE_RV_ACCEPT_ALL  (default) Select polygon if all path codes are found.
  DVE_RV_REJECT_ANY  Reject polygon if any one of the path codes are found.
  DVE_RV_REJECT_ALL  Reject polygon if exactly all the path codes are found.

Edge Code Qualifiers
Qualifier Resource Name: DVE_RN_PATH_CODE
Qualifier Resource Value:
  DVE_RV_TOP  (Default) Select edges on top that are outside bottom.
Conditional Selection

DVE_RV_BOT  Select edges on bottom that are outside top.
DVE_RV_TIB  Select edges on top that are inside bottom.
DVE_RV_BIT  Select edges on bottom that are inside top.
DVE_RV_INT  Select edges on top and bottom that are butting internally.
DVE_RV_EXT  Select edges on top and bottom that are butting externally.
Example

decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

decl lyrPolyCombine = NULL;
decl lyrPolyOverlap = NULL;
decl lyrPolyMerge = NULL;
decl lyrPoly = NULL;

lyrPolyCombine = dve_bool_or (lyrCond, lyrCond2);
lyrPolyOverlap = dve_bool_and (lyrCond, lyrCond2);
lyrPolyMerge = dve_bool_and (lyrPolyCombine, lyrPolyOverlap);
lyrPoly = dve_drc (poly_edge_code (lyrPolyMerge),
    DVE_RN_EDGE_SELECT, DVE_RV_ACCEPT_ANY,
    DVE_RN_PATH_CODE, DVE_RV_INT);

lyrError101 += dve_drc (all_edges (lyrPoly), "Conductive metal overlaps");

poly_path_count()

Select polygons based upon path count information computed during a merge operation. Input layer must be the result of a merge command. Returns: A polygon layer.

See also: dve_drc

Syntax

dve_drc (poly_path_count (inLayer) operator distance [, qualifierName, qualifierValue]);

where:

inLayer A polygon layer produced by a merge operation between two layers.

operator

< Less than

<= Less than or equal to

== Equal to

> Greater than

>= Greater than or equal to
Conditional Selection

value  An real value in layout units.
qualifierName, qualifierValue  A name-value pair that qualifies the rule.

Path Count Qualifier
Qualifier Resource Name: DVE_RN_PATH_COUNT
Qualifier Resource Value:
  DVE_RV_PATH_COUNT  (Default) Select based upon path count of top polygon.
  DVE_RV_ANTI_PATH_COUNT  Select based upon path count of bottom polygon.

Path Code Qualifiers
Qualifier Resource Name: DVE_RN_PATH_CODE
Qualifier Resource Value:
  DVE_RV_TOP  (Default) Select edges on top that are outside bottom.
  DVE_RV_BOT  Select edges on bottom that are outside top.
  DVE_RV_TIB  Select edges on top that are inside bottom.
  DVE_RV_BIT  Select edges on bottom that are inside top.
  DVE_RV_INT  Select edges on top and bottom that are butting internally.
  DVE_RV_EXT  Select edges on top and bottom that are butting externally.

Example
decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");
decl lyrPolyMerge = NULL;
decl lyrPoly = NULL;
lyrPolyMerge = dve_bool_not (lyrCond, lyrCond2);
lyrPoly = dve_drc (poly_path_count (lyrPolyMerge) >= 1,
  DVE_RN_PATH_CODE, DVE_RV_TOP,
  DVE_RN_PATH_CODE, DVE_RV_INT);
lyrError101 += dve_drc (all_edges (lyrPoly),
  "Metal layer outside and butting internally");
poly_path_length()

Select polygons based upon path length properties computed during a merge operation. Input layer must be the result of a merge command. Returns: A polygon layer.

See also: dve_drc

Syntax

dve_drc (poly_path_length (inLayer) operator distance [qualifierName, qualifierValue]);

where:

inLayer    A polygon layer produced by a merge operation between two layers
operator

<    Less than
<=   Less than or equal to
==   Equal to
>    Greater than
>=   Greater than or equal to

value    An real value in layout units

qualifierName, qualifierValue    A name-value pair that qualifies the rule

Path Type Qualifiers

Qualifier Resource Name: DVE_RN_PATH_LENGTH

Qualifier Resource Value

DVE_RV_MIN_PATH    Select based upon minimum path length of top polygon.
DVE_RV_MAX_PATH    Select based upon maximum path length of top polygon.
DVE_RV_TOTAL_PATH  Select based upon total path length of top polygon.
DVE_RV_MIN_ANTI_PATH   Select based upon minimum path length of bottom polygon.
Conditional Selection

DVE_RV_MAXANTI_PATH Select based upon maximum path length of bottom polygon.

DVE_RV_TOTALANTI_PATH Select based upon total path length of bottom polygon.

Path Code Qualifiers

Qualifier Resource Name: DVE_RN_PATH_CODE

Qualifier Resource Value:

DVE_RV_TOP (Default) Select edges on top that are outside bottom.

DVE_RV_BOT Select edges on bottom that are outside top.

DVE_RV_TIB Select edges on top that are inside bottom.

DVE_RV_BIT Select edges on bottom that are inside top.

DVE_RV_INT Select edges on top and bottom that are butting internally.

DVE_RV_EXT Select edges on top and bottom that are butting externally.

Example

dcl lyrCond = dve_import_layer ("cond");
dcl lyrCond2 = dve_import_layer ("cond2");
dcl lyrError101 = dve_export_layer ("error101");
dcl lyrPolyMerge = NULL;
dcl lyrPoly = NULL;
lyrPolyMerge = dve_bool_not (lyrCond, lyrCond2);
lyrPoly = dve_drc (poly_path_length (lyrPolyMerge) < 20.0,
    DVE_RN_PATH_CODE, DVE_RV_TOP,
    DVE_RN_PATH_LENGTH, DVE_RV_MIN_PATH);
lyrError101 += dve_drc (all_edges (lyrPoly),
    "Polygon path length < 20.0");
**Polygon Selection Based on Edge Relationships**

Polygon Selection Based on Edge Relationships (output layer contains polygons) selection function includes: `poly_inter_layer`.

**poly_inter_layer()**

Select polygons on one layer (`inLayer1`) in relation to edges of polygons on another layer (`inLayer2`) if any of the given constraints are true. Returns a polygon layer.

See also: `dve_drc`

**Syntax**

```dve_drc (poly_inter_layer (inLayer1, inLayer2) [, qualifierName, qualifierValue]);
```

where:

- `inLayer1, inLayer2` A polygon layers.
- `qualifierName, qualifierValue` A name, value pair that qualifies the selection.

**Selection Qualifier**

Qualifier Resource Name: DVE_RN_SELECT

<table>
<thead>
<tr>
<th>Qualifier Resource Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVE_RV_ACCEPT_ANY    Select polygon if any path codes are found.</td>
</tr>
<tr>
<td>DVE_RV_REJECT_ANY    Reject polygon if any one of the path codes are found.</td>
</tr>
</tbody>
</table>

**Poly Code Qualifiers**

Qualifier Resource Name: DVE_RN_INTER_CODE

<table>
<thead>
<tr>
<th>Qualifier Resource Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVE_RV_INSIDE_ONLY  (Default) Top is completely inside bottom and does not touch the inside of bottom.</td>
</tr>
<tr>
<td>DVE_RV_INSIDE_TOUCH, DVE_RV_INSIDE  The contained top does touch the inside of bottom (DVE_RV_INSIDE_ONLY or DVE_RV_INSIDE_TOUCH).</td>
</tr>
<tr>
<td>DVE_RV_OUTSIDE_ONLY Top is completely outside bottom and does not touch the outside of bottom.</td>
</tr>
</tbody>
</table>
Conditional Selection

DVE_RV_OUTSIDE_TOUCH, DVE_RV_OUTSIDE Top does touch the outside of bottom (DVE_RV_OUTSIDE_ONLY or DVE_RV_OUTSIDE_TOUCH).

DVE_RV_CUT_ONLY Top is partly inside bottom and partly outside bottom with no internal-butt with bottom, (that is, it does not touch the inside of bottom).

DVE_RV_CUT_TOUCH Top is partly inside bottom and partly outside bottom and does internal-butt (touch) bottom (DVE_RV_CUT_ONLY or DVE_RV_CUT_TOUCH).

DVE_RV_CUT_ANY, DVE_RV_ENCLOSE_ONLY Bottom is completely inside top, and does not touch the inside of top.

DVE_RV_ENCLOSE_TOUCH, DVE_RV_ENCLOSE The contained bottom does touch the inside of top (DVE_RV_ENCLOSE_ONLY or DVE_RV_ENCLOSE_TOUCH).

DVE_RV_CUT DVE_RV_CUT_ANY or DVE_RV_ENCLOSE

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

decl lyrPoly = NULL;
lyrPoly = dve_drc (poly_inter_layer (lyrCond, lyrCond2),
DVE_RN_INTER_CODE, DVE_RV_OUTSIDE);
lyrError101 += dve_drc (all_edges (lyrPoly), "Conductive metal outside");

lyrPoly = dve_drc (poly_inter_layer (lyrCond, lyrCond2),
DVE_RN_INTER_SELECT, DVE_RV_REJECT,
DVE_RN_INTER_CODE, DVE_RV_OUTSIDE_TOUCH,
DVE_RN_INTER_CODE, DVE_RV_INSIDE_TOUCH);
lyrError101 += dve_drc (all_edges (lyrPoly),
"Conductive metal outside and inside touch");
Chapter 5: Operations for Polygon Extraction from Edges

This section describes the DRC command used for polyextraction from edges. These functions include: dve_plgout and dve_quadout.

**dve_plgout()**

Extracts entire polygons from selected edges. If any section of a polygon is in error, then the entire polygon is extracted. Returns: A polygon layer.

See also: dve_quadout

**Syntax**

dve_plgout (edgeLayer);

where:

edgeLayer A layer containing selected edge segments. Edge segments are selected using the dve_drc command.

**Example**

dcl lyrCond = dve_import_layer ("cond");
dcl lyrError101 = dve_export_layer ("error101");

dcl lyrEdges1 = NULL;
dcl lyrEdges2 = NULL;
dcl lyrEdges3 = NULL;
dcl lyrPolyInterconnect = NULL;

//Identify sections of interconnect metal w/width >=2.0 and width <= 3.0

lyrEdges1 = dve_drc (width (lyrCond) < 2.0);
lyrEdges2 = dve_drc (invert_edges (lyrEdges1));
lyrEdges3 = dve_drc (width (lyrEdges2) < 3.0);
lyrPolyInterconnect = dve_plgout (lyrEdges3);

lyrError101 += dve_drc (all_edges (lyrPolyInterconnect),
"Valid interconnect");

**dve_quadout()**

Extracts a quadrilateral from the selected error segments on the given layer. Returns: A polygon layer.
Operations for Polygon Extraction from Edges

See also: dve_plgout

Syntax

dve_quadout (edgeLayer);

where:

dgeLayer  A layer containing selected edge segments. Edge segments are
d selected using the dve_drc command.

Example

decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

decl lyrEdges = NULL;
decl lyrPoly = NULL;
decl lyrPolySmall = NULL;

lyrEdges = dve_drc (width (lyrCond2) < 3.0,
                   DVE_RN_EDGE_ANGLES, DVE_RV_PARALLEL,
                   DVE_RN TEMPLATE, DVE_RV OPPOSITE);

lyrPoly = dve_quadout (lyrEdges);

lyrPolySmall = dve_drc (poly_line_length (lyrPoly) < 4.0,
                    DVE_RN_LINE_LENGTH, DVE_RV_MAX_LINE);

lyrError101 += dve_drc (all_edges (lyrPolySmall),
                     "Conductive metal length less than 4.0");
Chapter 6: Merge Operations on Polygons

This section describes the DRC commands used for merge operations on polygons. These functions include: dve_bool_and, dve_bool_not, dve_bool_or, dve_combine, dve_merge, and dve_self_merge.

dve_bool_and()    
Merges overlapping polygons on two given layers. Returns: A polygon layer.

Syntax

dve_bool_and (inLayer1, inLayer2);

where:

    inLayer1, inLayer2  A polygon layer.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");

decl lyrPoly = NULL;

lyrPoly = dve_bool_and (lyrCond, lyrCond2);

lyrError101 += dve_drc (all_edges (lyrPoly), "Conductive metal overlapping");

dve_bool_not()    
Subtracts shapes in the second layer from shapes in the first layer. Returns: A polygon layer.

Syntax

dve_bool_not (inLayer1, inLayer2);

where:

    inLayer1, inLayer2  A polygon layer.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrError101 = dve_export_layer ("error101");
Merge Operations on Polygons

```plaintext
dcl lyrPoly = NULL;
lyrPoly = dve_bool_not (lyrCond, lyrCond2);
lyrError101 += dve_drc (all_edges (lyrPoly),
  "Conductive metal not overlapping");
lyrPoly = dve_bool_not (lyrCond2, lyrCond);
lyrError101 += dve_drc (all_edges (lyrPoly),
  "Conductive metal not overlapping");

**dve_bool_or()**
Merges overlapping shapes on a given layer. Returns: A polygon layer.
Syntax
```
outLayer = dve_bool_or (inLayer1 [, inLayer2]);
``` where:
```
inLayer1, inLayer2  A polygon layer.
```
Example
```plaintext
dcl lyrCond = dve_import_layer ("cond");
dcl lyrCond2 = dve_import_layer ("cond2");
dcl lyrError101 = dve_export_layer ("error101");

dcl lyrPoly = NULL;
lyrPoly = dve_bool_or (lyrCond, lyrCond2);
lyrError101 += dve_drc (width (lyrPoly) < 3.0,
  "Conductive metal less than 3.0");
```

**dve_combine()**
Combines shapes on multiple layers into one layer without modifying the shapes. Results of a combine command can only be used in a dve_drc command. Returns: A polygon layer.
Syntax
dve_combine ( inLayer1 [, inLayer2, . . ., inLayerN])
where:
inLayer1, inLayer2, inLayerN  A polygon layer.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrDiel = dve_import_layer ("diel");
decl lyrError101 = dve_export_layer ("error101");

decl lyrPolyAll = NULL;
lyrPolyAll = dve_combine (lyrCond, lyrCond2, lyrDiel);

lyrError101 += dve_drc (single_clearance (lyrPolyAll) < 2.0, "Metal less than 2.0",
                      DVE_RN_POLARITY, DVE_RV_INSIDE,
                      DVE_RN_TEMPLATE, DVE_RV_ROUND);

dve_merge()
Merge shapes on multiple layers into one layer. Returns: A polygon layer.

Syntax

dve_merge ( inLayer1[, inLayer2, ... , inLayerN])

where:

    inLayer1, inLayer2, inLayerN  A polygon layer that is not the result of a
dve_merge.

Example

decl lyrCond = dve_import_layer ("cond");
decl lyrCond2 = dve_import_layer ("cond2");
decl lyrDiel = dve_import_layer ("diel");
decl lyrError101 = dve_export_layer ("error101");

decl lyrMerge = NULL;
lyrMerge = dve_merge (lyrCond, lyrCond2, lyrDiel);

lyrError101 += dve_drc (corner_edges (lyrMerge, 1.5, 90.5, 360.0), "Concave corner edges");
Merge Operations on Polygons

**dve_self_merge()**

Merge shapes on multiple layers into one layer, selecting only polygons on the first that come from the same original merge group as the second layer. Returns: A polygon layer.

**Syntax**

dve_self_merge (inLayer1, inLayer2)

where:

inLayer1, inLayer2 A polygon layer.

**Example**

```c
decl lyrCond = dve_import_layer ("cond");
dcl lyrCond2 = dve_import_layer ("cond2");
dcl lyrError101 = dve_export_layer ("error101");

dcl lyrPolyMerge = NULL;
dcl lyrPoly1 = NULL;

lyrPolyMerge = dve_self_merge (lyrCond2, lyrCond);

lyrPoly1 = dve_drc (poly_edge_code (lyrPolyMerge),
    DVE_RN_EDGE_SELECT, DVE_RV_ACCEPT_ALL,
    DVE_RN_PATH_CODE, DVE_RV_TOP);

lyrError101 += dve_drc (all_edges (lyrPoly1),
    "Conductive metal outside");

lyrPoly1 = dve_drc (poly_edge_code (lyrPolyMerge),
    DVE_RN_EDGE_SELECT, DVE_RV_ACCEPT_ALL,
    DVE_RN_PATH_CODE, DVE_RV_TIB);

lyrError101 += dve_drc (all_edges (lyrPoly1),
    "Conductive metal inside");
```
Chapter 7: Troubleshooting

If a dve_drc command is not producing the expected output, try the following debugging techniques:

- Resolve any compile errors or warnings.
- Check to make sure the dve_drc command has an error message.
- If possible, always use < for clearance rules to ensure a bounded check.
- Inspect the input layers using the layer editor. Send the data to an export layer (be sure to include an error message), and view the data using Load Results.

Layer Management Errors (101-199)

101 Import layer must be a design layer
Import and export layers must be defined as physical design layers

102 Export layer must be a design layer
Import and export layers must be defined as physical design layers

103 No output layer
An output layer is required on the left-hand side of the equal sign (=).

104 Layer parameter is uninitialized
Input layers must have previously appeared on the left-hand side of an equal sign (=).

105 Layer parameter is an export layer
An input layer that has been declared as an export layer cannot be used as an input layer.

106 No import layers defined
At least one input layer must be defined.
Troubleshooting

107 No export layers defined
At least one export layer must be defined.

108 Rules do not generate output
At least one rule must assign data to an export layer.

Layer Management Warnings (201-299)

201 Redefining an import layer
A layer that has been declared as an import layer is being redefined.

202 Redefining an export layer
A layer that has been declared as an export layer is being redefined.

Command Usage Errors (301-399)

301 Expecting layer parameter
Parameter is uninitialized or is not a layer. Please see documented command syntax.

302 Expecting a string parameter
Parameter is uninitialized or is not a string. Please see documented command syntax.

303 Expecting an integer parameter
Parameter is uninitialized or is not an integer number. Please see documented command syntax.

304 Expecting a real parameter
Parameter is uninitialized or is not a real number. Please see documented command syntax.
305 Invalid angle parameter
Expecting a real number greater than 0 and less than 360 with only one decimal point of precision.

306 Command is a dve_drc subfunction
Command must appear as the first parameter to a dve_drc subfunction. Command is not valid outside the context of a dve_drc command.

307 Unsupported operator
The dve_drc expression contains an unrecognized operator. Valid operators are

- `< Less than
- `<= Less than or equal to
- `== Equal to
- `> Greater than
- `>= Greater than or equal to

308 Unsupported set operator
The command is missing the left-hand equal sign for assignment to an output layer.

309 Missing elements of expression
The command requires an expression. Please see the documented command syntax.

310 Expecting polygon layer
Polygon layers are produced as the result of polygon selection or boolean commands. Edge operation commands perform segment merging, sizing and polygon extraction on selected edges.

311 Expecting edge layer
Edge layers are produced as the result of an edge selection, edge compensation, or edge operation command. Polygon commands perform polygon selection and boolean operations on polygons.
Troubleshooting

312 Expecting boolean merge layer
Polygon selection commands based on merge properties only accept input layers that are the direct result of a boolean polygon merge operation such as dve_bool_and.

313 Expecting dve_drc subfunction
The dve_drc command must always appear with a dve_drc subfunction as the first parameter.

314 Nested merge not allowed
The result of a dve_merge command cannot be used as the input to another dve_merge command.

Command Usage Warnings (401-499)

401 Expression ignored
Command does not require an expression

402 Qualifier ignored
Resource qualifiers that do not apply are ignored. Please see documented command syntax.

403 Using default polarity
A polarity specification is required for commands double_clearance and single_clearance. If no polarity is specified, a polarity DVE_RV_OUTSIDE is used.

404 Using default template
A template specification is required for commands double_clearance and single_clearance. If no template is specified, a template DVE_RV_OPPOSITE is used.

405 Clearance qualifiers ignored
Clearance qualifiers require an upper bound and are currently not supported for unbounded greater-than (>) or greater-than-or-equal (>=). This can be corrected by using range comparisons.
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