IC Validator
Deck Creation and Validation Toolkit
User Guide

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SYNOPSYS®

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Contents

Preface

This preface includes the following sections:

- About This User Guide
- Customer Support

About This User Guide

This user guide describes the Deck Creation and Validation (DCV) Toolkit utilities for the IC Validator tool.

Audience

This user guide is designed to enhance the knowledge that both beginning and advanced IC Validator users have of the DCV Toolkit.

Related Publications

For additional information about the IC Validator tool, see the documentation on the Synopsys SolvNet® online support site at the following address:

https://solvnet.synopsys.com/DocsOnWeb

You might also want to see the documentation for the following related Synopsys products:

- Custom Compiler™
- IC Compiler™
- IC Compiler™ II
- StarRC™

Release Notes

Information about new features, enhancements, changes, known limitations, and resolved Synopsys Technical Action Requests (STARs) is available in the *IC Validator Release Notes* on the SolvNet site.

To see the *IC Validator Release Notes*,

1. Go to the SolvNet Download Center located at the following address:

   https://solvnet.synopsys.com/DownloadCenter

2. Select IC Validator, and then select a release in the list that appears.

Conventions

The following conventions are used in Synopsys documentation.

Convention	Description
`Courier`	Indicates syntax, such as `write_file`.
`Courier italic`	Indicates a user-defined value in syntax, such as `write_file` *`design_list`*.
`Courier bold`	Indicates user input—text you type verbatim—in examples, such as `prompt>` **`write_file top`**
[ ]	Denotes optional arguments in syntax, such as `write_file [-format` *`fmt`*`]`
...	Indicates that arguments can be repeated as many times as needed, such as *`pin1 pin2 ... pinN`*
|	Indicates a choice among alternatives, such as `low | medium | high`
Ctrl+C	Indicates a keyboard combination, such as holding down the Ctrl key and pressing C.
\	Indicates a continuation of a command line.
/	Indicates levels of directory structure.
Edit > Copy	Indicates a path to a menu command, such as opening the Edit menu and choosing Copy.

Customer Support

Customer support is available through SolvNet online customer support and through contacting the Synopsys Technical Support Center.

Accessing SolvNet

The SolvNet site includes a knowledge base of technical articles and answers to frequently asked questions about Synopsys tools. The SolvNet site also gives you access to a wide range of Synopsys online services including software downloads, documentation, and technical support.

To access the SolvNet site, go to the following address:

https://solvnet.synopsys.com

If prompted, enter your user name and password. If you do not have a Synopsys user name and password, follow the instructions to sign up for an account.

If you need help using the SolvNet site, click HELP in the top-right menu bar.

Contacting the Synopsys Technical Support Center

If you have problems, questions, or suggestions, you can contact the Synopsys Technical Support Center in the following ways:

- Open a support case to your local support center online by signing in to the SolvNet site at https://solvnet.synopsys.com, clicking Support, and then clicking “Open A Support Case.”
- Send an e-mail message to your local support center.
  - E-mail support_center@synopsys.com from within North America.
  - Find other local support center e-mail addresses at

    https://www.synopsys.com/support/global-support-centers.html
- Telephone your local support center.
  - Call (800) 245-8005 from within North America.
  - Find other local support center telephone numbers at

    https://www.synopsys.com/support/global-support-centers.html

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Introduction to Deck Creation and Validation

This chapter provides an introduction to IC Validator Deck Creation and Validation (DCV) Toolkit.

The DCV Toolkit is a set of utilities that helps you to create and validate DRC, LVS, and Fill runsets. You can configure and execute each of the tools in the toolkit, review the results, and validate or improve the quality and performance of your runsets.

For more information, see the following section:

- DCV Toolkit

DCV Toolkit

The DCV Toolkit consists of the following tools:

- DCV Analyzer

  Use this tool to analyze the performance of an IC Validator run. The tool creates organized reports that can help you to identify factors limiting overall performance.

  For more information, see Chapter 2, “DCV Analyzer Tool.”

- DCV Switch Optimizer

  This tool validates the syntax correctness of an IC Validator runset. The tool identifies and exercises a minimal set of runset preprocessor flow-control switches that exercise all of the code in the runset, and then reports any combinations that produce a runtime parser error.

  For more information, see Chapter 3, “DCV Switch Optimizer Tool.”

- DCV Results Compare

  This tool validates the quality of IC Validator output results. The tool compares two sets of error output results and identifies discrepancies between them.

  For more information, see Chapter 4, “DCV Results Compare Tool.”

- DCV Test Case Compiler

  This tool generates non-functional layout database files for use in testing the IC Validator tool.

  For more information, see Chapter 5, “DCV Test Case Compiler Tool.”

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DCV Analyzer Tool

This chapter explains how to run the DCV Analyzer tool and view the reports.

The IC Validator DCV Analyzer tool serves as a starting point for analyzing the performance of an IC Validator run.

For more information, see the following sections:

- Overview
- Running the Tool
- Analyzing Performance
- Analyzing and Comparing Hierarchies

Overview

The DCV Analyzer tool takes the output of an IC Validator run and displays the data in a clear, organized way. In some cases, this data is equivalent to the data created by other sources, such as the scripts in the contrib directory; however, the DCV Analyzer tool uses a more predictable method to create and present the data. In other cases, the tool creates data that is not available elsewhere. In either case, you should use this tool as the starting point for IC Validator performance analysis.

You can use the DCV Analyzer tool to

- Analyze performance using the distributed log file from an IC Validator run
- Analyze hierarchy using a tree structure file from an IC Validator run
- Compare hierarchies using two tree structure files from the same or different IC Validator runs

You can perform each of these tasks individually or perform any combination of them in a single DCV Analyzer run. The tool determines which operations to perform based on the input files that you specify.

- Distributed log files contain information about the commands that IC Validator executed during a run.
- Tree structure files contain information about the design hierarchy tree.

These IC Validator output files are located in the run_details directory. For more information about the files, see the *IC Validator User Guide*.

By default, the DCV Analyzer tool takes input from the files that you specify, stores the data in an SQLite database, analyzes the data, and provides output in report files. In general, the tool performs the following operations:

1. Parses the distributed log file or tree structure files and loads the input data into an SQLite database
2. Analyzes the data from the SQLite database and generates reports

In subsequent runs, the tool can reanalyze the data and regenerate or add reports from the same SQLite database.

For performance analysis, the tool provides output in a summary report file and a user-functions file. The summary report file contain runtime statistics, efficiency metrics, and tables highlighting discrete aspects of the run, such as the runset functions that took the longest or used the most memory.

Optional output includes individual table report files, in tab-separated-value format, that you can import into a third-party tool, such as the Microsoft® Excel® tool, for further analysis. You can also generate command chain files for long-pole analysis. In addition, you can customize the number of table rows in the reports.

For hierarchy analysis, the tool provides output in a tree summary report file named tree_summary.txt. Optional output can include cell and layer report files. For hierarchy comparisons, the tool provides additional output in a tree comparison file named tree_compare.txt.

Running the Tool

Before running the DCV Analyzer tool, make sure your `LM_LICENSE_FILE` and `ICV_HOME_DIR` environment variables are set. The `dcv_analyzer` executable is located in the same bin directory as the `icv` executable. The tool creates the database and report files in your current working directory.

The DCV Analyzer command-line syntax is

```
dcv_analyzer [options] [runset.dp.log] [top-cell.treeX] [top-cell.treeX]
```

where

- *options* are described in Table 2-1 on page 2-4
- *runset*.dp.log is the name of the distributed log file from an IC Validator run
- *top-cell*.tree*X* specifies the name of a tree structure file from an IC Validator run

  You can specify one tree structure file for hierarchy analysis or two tree structure files to compare the hierarchies. The files can come from the same or different IC Validator runs. In the tree structure file names, *X* is an integer from 0 to 999. The format of the tree structure files (Milkyway, NDM, LTL, GDSII, or OASIS) does not matter.

For more information, see the following sections:

- Command-Line Options
- Environment Variables

Command-Line Options

Table 2-1 describes the command-line options.

Table 2-1 DCV Analyzer Command-Line Options

Option	Description
`-c` *`count`* `| all`	Specifies the number of records for fields in the report. By default, the tool generates 10 records for most fields. The *count* must be a positive integer. Use `all` if you want the tool to return all records by the sort order.

`-C` *`cell-list`*
`-cell` *`cell-list`*
	Specifies a comma-separated list of cell names in *cell-list*. The tool provides cell statistics for each cell in cell information files named cell_*cellname*.txt. At least one tree structure input file (*top-cell*.tree*X*) must be provided.
	You can use the asterisk wildcard character (*) to specify multiple cells in a name pattern. When using wildcard characters, you should enclose the entire argument in quotation marks to prevent the shell from interpreting files in the current working directory.

`-e` `-export`	Provides the output data in table-based report files named *_table.tsv. You can import these tab-separated-values files into the Microsoft Excel tool for further analysis.

`-f` *`command_key`*
`-full-cmdhist` *`command_key`*
	Specifies a comma-separated list of the command keys (for example, 1234.0.0) used to generate the full command dependency history. If the first element in a *command_key* is a positive integer, the tool produces that number of worst-case graphs. The output file name format is fullHist_*command_key*.txt. Each full history file shows all dependencies which ran to reach the command key. These are shown in command execution order, not dependency order.

`-F` *`violation_comment`*
`-full_cmd-violation` *`violation_comment`*
	Produces the same fullHist_*command_key*.txt files that the `-f` command-line option produces, but uses the *violation-list* comments as the input. Enclose each comment in quotation marks and separate the comments with commas. For example, `"*a*","b*"` (where `*` is a wildcard character).

`-h` `-help`	Displays the usage message and exits.

Table 2-1 DCV Analyzer Command-Line Options (Continued)

Option	Description

`-l` *`command_key`*
`-long-pole-hist` *`command_key`*
	Specifies a comma-separated list of the command keys (for example, 1234.0.0) used to generate the long-pole history. If the first element in a *command_key* is a positive integer, the tool produces that number of worst-case graphs. The output file name format is cmdchain_*command_key*.txt. Each command chain file shows the longest serial path of dependencies to reach the command key.

`-L` *`layer-list`*
`-layer` *`layer-list`*
	Specifies layers in a comma-separated list of layer names, layer number and data type pairs, or both. The tool provides layer statistics for each layer in layer information files named layer_*layer-name*.txt for each layer name and *layer_num*:*data_type*.txt for each layer number and data type pair.
	You must provide at least one tree structure input file (*top-cell*.tree*X*) when you use this option. If *layer-list* contains layer number and data type pairs, the tree structure input file must be a single *top-cell*.tree0 file.
	You can use the asterisk wildcard character (*) to specify multiple layers in a layer name pattern. When using wildcard characters, enclose the entire argument in quotation marks to prevent the shell from interpreting files in the current working directory.
	Wildcard characters are not allowed in a layer number and data type pair. Specify each pair by using the form *`layer-number`*`:`*`data-type`*, where *layer-number* and *data-type* are integers.
	For example, `“M1,1:0,D*”` specifies layer name M1, layer number and data type pair 1:0, and layer name pattern D*. The quotation marks prevent the shell from expanding D*.

`-r` `-report-only`	Regenerates the reports using the data in the SQLite database from a previous run instead of parsing and analyzing the data from the distributed log file. At least one input file (dplog.db or tree.db) must be present in the current working directory.
`-t` `-tabs`	Changes the output file name extensions to .tsv and the file format to tab separation instead of fixed-width printing. This option allows you to more easily import an output file into the Microsoft Excel tool or to parse specific fields in a file by using a script.

`-v` *`violation-list`*
`-violation-cmdchain` *`violation-list`*
	Produces the same cmdchain_*command_key*.txt files that the `-l` command-line option produces, but uses the *violation-list* comments as the input. Enclose each comment in quotation marks and separate the comments with commas. For example, `"*a*","b*"` (where `*` is a wildcard character).

Table 2-1 DCV Analyzer Command-Line Options (Continued)

Option	Description
`-V` `-version`	Prints the tool version.

`-x` *`XREF`*
`-xref` *`XREF`*
	Changes the content of the field used to cross-reference the SQLite database. *XREF* can be `key`, `number`, or `line`. The default is `key`.
	• `key` prints the command key
	• `number` prints the command number
	• `line` prints the line number from the dp.log file
	In the following example, line 7105 from a distributed log file contains the command key 1337.0.0 and the command number 3163:
	`Host teralab-48(0) completes 1337.0.0, 3163:`

Environment Variables

When the DCV Analyzer tool detects an environment variable that affect its behavior, it notifies you in the standard output. For example:

```
11:15:44 Creating file: dplog_summary.txt
   INFO: Using Env Var: "DCV_USER_FUNCTION_VALUES" with value:
         "CUMULATIVE"
11:15:44 Creating file: userfunction_summary.txt
```

You can control the appearance of the standard output and log files by setting the following DCV Analyzer environment variables:

- `DCV_USER_FUNCTION_LOOP`

  Set this variable to control how loops are displayed in the User Function related reports. The `DISCRETE` setting splits all of the loop data into separate information for each iteration of the loop. The `CUMULATIVE` setting ignores all of the loop information at the top level and reports totals for all of the passes of loop data involved with the user functions. The `BOTH` setting prints two tables, one with each of the other values. The default is `DISCRETE`.

  Example 2-1 and Example 2-2 show the differences in the Slowest User Functions sorted by Check Time when the `DCV_USER_FUNCTION_LOOP` is `DISCRETE` (the default) versus `CUMULATIVE`.

Example 2-1 DCV_USER_FUNCTION_LOOP is DISCRETE

```
-----------------------------------------------------------------------------
Slowest User Functions Sorted by Check Time:
-----------------------------------------------------------------------------
```

```
User Function                                       Intrinsic   Avg      Total
                                                       Count     Check    Time
                                                                  Time(min) Time(min)^
top_level_uf@analyzerDocs.rs:329/
             random_repeater@analyzerDocs.rs:224        3           0.1        0.4
top_level_uf@analyzerDocs.rs:329/sub1@analyzerDocs.rs:225/
sub2@analyzerDocs.rs:202                   2           0.0        0.1
top_level_uf@analyzerDocs.rs:329                       4           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             random_repeater@analyzerDocs.rs:210        3           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             sub2@analyzerDocs.rs:211                   2           0.0        0.0
copyOut@analyzerDocs.rs:331                            1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             esd_interact@analyzerDocs.rs:230.foreach-1 1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             esd_interact@analyzerDocs.rs:230.foreach-2 1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             sub1@analyzerDocs.rs:225                   1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             no_intrinsic@analyzerDocs.rs:226           0           0.0        0.0

DCV_USER_FUNCTION_LOOP: DISCRETE DCV_USER_FUNCTION_VALUES: DISCRETE


-------------------------------------------------------------------------------------
```

Example 2-2 DCV_USER_FUNCTION_VALUES is CUMULATIVE

```
-------------------------------------------------------------------------------------
Slowest User Functions Sorted by Check Time:
-------------------------------------------------------------------------------------
User Function                                       Intrinsic   Avg      Total
                                                       Count     Check    Time
                                                                  Time(min) Time(min)^
top_level_uf@analyzerDocs.rs:329/
             random_repeater@analyzerDocs.rs:224        3           0.1        0.4
top_level_uf@analyzerDocs.rs:329/sub1@analyzerDocs.rs:225/
             sub2@analyzerDocs.rs:202                   2           0.0        0.1
top_level_uf@analyzerDocs.rs:329                       4           0.0        0.0
copyOut@analyzerDocs.rs:331                            1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
              esd_interact@analyzerDocs.rs:230          2           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             random_repeater@analyzerDocs.rs:210        3           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             sub2@analyzerDocs.rs:211                   2           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             sub1@analyzerDocs.rs:225                   1           0.0        0.0

DCV_USER_FUNCTION_LOOP: CUMULATIVE DCV_USER_FUNCTION_VALUES: DISCRETE


-------------------------------------------------------------------------------------
```

- `DCV_USER_FUNCTION_VALUES`

Set this variable to control how the values (Elapsed Time, Check Time, User Time, System Time, Memory and Intrinsic counts) from nested user functions are displayed in the User Function related reports. The `DISCRETE` setting reports only the values from intrinsics called natively in the user function. The `CUMULATIVE` setting includes values from all of the nested user functions called from the higher-level functions. The `BOTH` setting prints two tables, one with each of the other values. The default is `DISCRETE`.

Example 2-3 and Example 2-4 show the differences in the Slowest User Functions sorted by Check Time when the `DCV_USER_FUNCTION_VALUES` is `DISCRETE` (the default) versus `CUMULATIVE`.

The highlighted intrinsic count numbers of the `DISCRETE` example equal the highlighted intrinsic count number of the `CUMULATIVE` example.

Example 2-3 DCV_USER_FUNCTION_VALUES is DISCRETE

```
-------------------------------------------------------------------------------------
Slowest User Functions Sorted by Check Time:
-------------------------------------------------------------------------------------
User Function                                         Intrinsic    Avg       Total
                                                         Count      Check     Time
                                                                    Time(min) Time(min)^
top_level_uf@analyzerDocs.rs:329/
             random_repeater@analyzerDocs.rs:224        3           0.1        0.4
top_level_uf@analyzerDocs.rs:329/sub1@analyzerDocs.rs:225/
sub2@analyzerDocs.rs:202                                2           0.0        0.1
top_level_uf@analyzerDocs.rs:329                        4           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             random_repeater@analyzerDocs.rs:210        3           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             sub2@analyzerDocs.rs:211                   2           0.0        0.0
copyOut@analyzerDocs.rs:331                             1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             esd_interact@analyzerDocs.rs:230.foreach-1 1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             esd_interact@analyzerDocs.rs:230.foreach-2 1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             sub1@analyzerDocs.rs:225                   1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             no_intrinsic@analyzerDocs.rs:226           0           0.0        0.0

DCV_USER_FUNCTION_LOOP: DISCRETE DCV_USER_FUNCTION_VALUES: DISCRETE


-------------------------------------------------------------------------------------
```

Example 2-4 DCV_USER_FUNCTION_VALUES is CUMULATIVE

```
-------------------------------------------------------------------------------------
Slowest User Functions Sorted by Check Time:
-------------------------------------------------------------------------------------
User Function                                         Intrinsic   Avg      Total
                                                         Count     Check    Time
                                                                    Time(min) Time(min)^
top_level_uf@analyzerDocs.rs:329                        17          0.0         0.5
top_level_uf@analyzerDocs.rs:329/
```

```
             random_repeater@analyzerDocs.rs:224        3           0.0        0.4
top_level_uf@analyzerDocs.rs:329/
             sub1@analyzerDocs.rs:225                   3           0.0        0.1
top_level_uf@analyzerDocs.rs:329/sub1@analyzerDocs.rs:225/
             sub2@analyzerDocs.rs:202                   2           0.0        0.1
copyOut@analyzerDocs.rs:331                             1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             esd_interact@analyzerDocs.rs:230.foreach-1 1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             esd_interact@analyzerDocs.rs:230.foreach-2 1           0.0        0.0
top_level_uf@analyzerDocs.rs:329/
             no_intrinsic@analyzerDocs.rs:226           5           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             random_repeater@analyzerDocs.rs:210        3           0.0        0.0
top_level_uf@analyzerDocs.rs:329/no_intrinsic@analyzerDocs.rs:226/
             sub2@analyzerDocs.rs:211                   2           0.0        0.0

DCV_USER_FUNCTION_LOOP: DISCRETE DCV_USER_FUNCTION_VALUES: CUMULATIVE


---------------------------------------------------------------------------------------
```

- `DCV_HEADER_FORMAT`

  Set this variable to control the alignment of the Run Time Summary, Run Information, and Efficiency Metrics sections in the dplog_summary.txt file. The valid settings are `PINCH`, `SPLIT`, `LEFT`, `RIGHT`, and `CENTERED`. The default is `CENTERED`.

- `DCV_PROGRESS_SECONDS`

  Set this variable to change the frequency of Progress Line updates. The value must be an integer. The default is `60`.

- `DCV_PROGRESS_PERCENT`

  Set this variable to change the frequency of Progress Line percentage updates. The value must be an integer. The default is `10`.

- `DCV_UNICODE`

  Set this variable to `1` to allow the DCV Analyzer tool to print Unicode characters in the output report files. When you set this variable, the tool replaces `+INF` with the infinity character (∞).

  Note:
  Before setting this variable, make sure that everything you are using (shell, display, text editor, and so forth) supports Unicode characters.

The `DCV_PROGRESS_SECONDS` and `DCV_PROGRESS_PERCENT` variables work together. For example, if you set the seconds to `60` and the percent to `50`, and the run takes approximately three minutes, updates occur at 60 seconds, at 90 seconds (due to the 50 percent setting), at 120 seconds, and at 180 seconds.

In addition, setting these variables to artificially high values (more seconds than you think the job should take or a percentage equal to 100 or more) effectively disables the timer.

Analyzing Performance

For performance analysis, the DCV Analyzer tool takes input from a distributed log file and stores the data in an SQLite database, named dplog.db, in the current working directory. Then, the tool analyzes the data and generates reports.

By default, the tool provides summary information for performance analysis in a summary report file, named dplog_summary.txt, and detailed information about the user functions from the runset in a user-functions file, named userfunction_summary.txt. The summary report file contains runtime statistics, efficiency metrics, and tables highlighting discrete aspects of the run, such as the runset commands that took the longest or used the most memory.

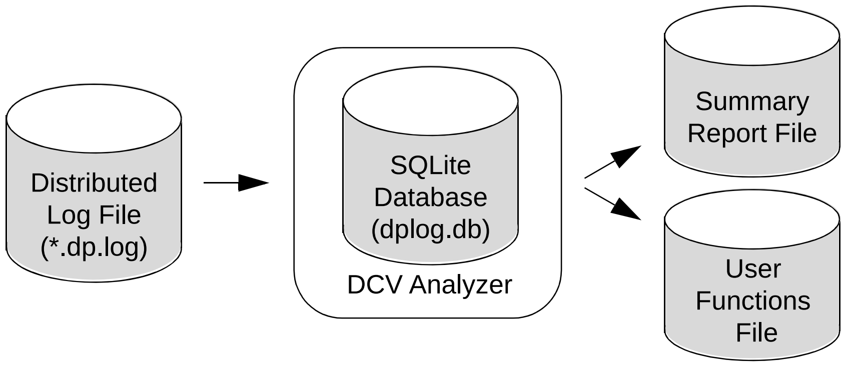
For example, you can enter the following command:

```
# dcv_analyzer runset1.dp.log
```

The tool generates the SQLite database, the summary report file, and the user-functions file in the current working directory. Most of the runtime involves creating the SQLite database. For subsequent runs with the same runset data, you can use the `-r` command-line option to reanalyze the data and regenerate or add reports from the same SQLite database.

Figure 2-1 illustrates this flow.

Figure 2-1 DCV Analyzer Performance Analysis Flow



For example, to increase the number of table rows to 15 in the summary report file, you can enter

```
# dcv_analyzer -c 15 -r
```

The tool generates additional output files depending on the options that you include on the `dcv_analyzer` command line.

- Table report files

  Use the `-e` command-line option to generate table-based report files, named *table-name*_table.tsv, that provide data from the database tables. You can import these tab-separated values files into the Microsoft Excel tool for further analysis.

- Command chain files

  Use the `-l` command-line option to specify the command keys that the tool uses to generate the long-pole history. The tool generates an output file for each command key. These files, named cmdchain.*command_key*.txt, show selected information about the command-chain critical paths to the specified command keys.

For example, to find information about command key 1234.0.0, export the table-based reports in tab-separated-value files by entering the following command:

```
% dcv_analyzer -l 1234.0.0 -e -r
```

For more information about the performance analysis output files, see the following sections:

- Summary Report File
- User-Functions File
- Table Report Files
- Command Chain and Full History Files

Summary Report File

The summary report file is the main DCV Analyzer output file. This file contains the performance information highlighted by each run.

The top of this report contains summary information about

- The method and tool versions used to run the DCV Analyzer and IC Validator tools
- The elapsed time and the sum of the elapsed, user, and system times
- The peak and average memory experienced by each host, the number of CPUs used, and the total physical memory available on the host

  The average memory is calculated by adding, for each aperiodic interval, the peak memory divided by the interval period. The memory is reported in gigabytes (GB).

- Run information that shows many basic statistics for the run

The IC Validator tool reports time measurements in elapsed time, check time, user time, and system time. Table 2-2 describes these time measurements.

Table 2-2 IC Validator Time Measurements

Type	Description
Elapsed time	The time that you can measure with a clock while the job runs (also referred to as the “wall time”). The tool retrieves elapsed times from an independent timer that prints timestamps during the run. The Sum of Command Elapsed Time value is the sum of all the individual commands. For a single-CPU run, the elapsed time is equal to the sum of elapsed times. For multiple-CPU runs, parallel processing makes the sum of elapsed times greater than the IC Validator elapsed time.
Check time	The time measured by a command and reported as `Check Time=`. Most commands report the check time; however, some commands use a different descriptor instead of `Check` and some commands do not report this time. Some engine commands may execute a second command that the master scheduler is not aware of (such as a hierarchical read), in these cases more than one “Check Time=” line will be present. When this happens The DCV Analyzer tool attempts to store the main command in the main table and stores the other commands in a secondary table. It is possible for Elapsed and Check times to be quite different in these cases. In most other cases, the check and elapsed times should be within one second of each other, making them effectively the same.
User time	The time spent by the CPU doing work for the IC Validator tool. Threading makes this number higher than the elapsed time for a single command. These times are reported as `User Time=` for each command. The Sum of Command User Time value is the sum of this number for all commands.
System time	The time reported as `Sys=` for each command. System times represent the amount of time the operating system spends helping the IC Validator tool, for example, to copy a file. In general, system times are relatively low. High system times usually indicate that machine resource contention is affecting the IC Validator runtime. For example, the machine might be paging from high memory usage, or the CPU load average might exceed the amount of available processors on the machine. These problems can exist either because of the current IC Validator run or because of unrelated processes running on the machine.

In addition to the runtime and memory, the statistics for an IC Validator run can include information about the parse time, assigned layers, number of commands used in the run, number of DRC rules, and disk statistics. Table 2-3 describes these IC Validator run statistics.

Table 2-3 IC Validator Run Statistics

Type	**Description**
Parse time	The amount of time the IC Validator tool took to parse the runset. (Cache hits are shown in parentheses.)
Non-empty assign layers	The count of layers in `assign()` function calls that contain at least one object.
Assign layer objects	The sum of all the data read in from `assign()` function calls.
Executed engine commands	A count of the discrete processes the engine performed to complete the run. This count includes the generic processes that are independent of the runset and all of the processes directed by the runset. The same runset might produce different numbers depending on the command-line options that you use to run the IC Validator tool (the number of CPUs) and any preprocessor directives or other flow-control and empty-layer optimizations that the tool performs during the run.
Longest Command Chain	The longest serial path of dependencies in the run. This generally depicts the runtime performance threshold.
Number of rules executed	The number of unique text strings that can potentially write data to the LAYOUT_ERRORS file. A rule in PXL notation is defined as: `Rule1 @= { @ "some-description"; pxl_function( layers, constraints, options); }` These rules do not have to be proper DRC rules. They can be ERC checks or debug statements that you include in the runset.
Number of rules with violations	Shows the number of rules in the runset that produced violations.

Table 2-3 IC Validator Run Statistics (Continued)

Type	Description
Error-producing commands	The number of engine commands with the following comment in the distributed log file: `Comment: "some-description"` The number of error-producing commands might exceed the number of rules due to duplicate comments in the runset, looping, or other engine optimizations that can occur for more complex commands.
Violation	Any output shape reported by the error-producing commands. The DCV Analyzer tool shows counts for both the rules and error-producing commands and the total violations found.
Disk usage	Reports the amount of space at the peak and end of the IC Validator run.

All efficiency metrics should be well defined by the equations used in the file to derive them and should be consistent with the terms described in Table 2-3.

Example 2-5 shows an example of the summary information at the top of the summary report file.

Example 2-5 Summary Information Example

```
DCV_Analyzer, M-2017.06 2017/04/24
Called as: dcv_analyzer ../run/run_details/analyzerDocs.dp.log

Summary for analysis of
/remote/DCV/lab/DCV_Analyzer_lab/run/run_details/analyzerDocs.dp.log

dp.log Header Information:
-------------------------
  Version L-2016.06 for linux64 - May 08, 2016 cl#3129124
  Called as: icv -f OASIS ../input_files/analyzerDocs.rs


Run Time Summary:
----------------
                      ICV Elapsed Time: 1.7 hours
              Sum of Command User Time: 3.0 hours
           Sum of Command Elapsed Time: 3.3 hours
            Sum of Command System Time: 0.2 hours

Host Information:
----------------
                               |            Memory (GB)             |
Host Name                 CPUs |  Average     Peak  Physical   Swap | Architecture
               Allocated/Total |     Used     Used Available  Space | Information
-------------- --------------- | -------- -------- --------- ------ | ----------------
attoemt608                2/20 |      1.7      9.1     504.8  200.0 | Intel(R) Xeon(R)
                                                                        CPU E5-2690
```

```
                                                                               v2 @ 3.00GHz
------------- -------------- | -------- ------- -------- ------ | ---------------
Total (1)                2/20 |                                 |


Run Information:
-----------------
                                            Parse Time (seconds): 8
                                         Non-Empty Assign Layers: 24
                                            Assign Layer Objects: 280,165,130
                                        Executed Engine Commands: 507
                                   Longest Command Chain (hours): 0.4
                                        Number of Rules Executed: 186
                                 Number of Rules with Violations: 25
                                        Error-Producing Commands: 192
                        Error-Producing Commands with Violations: 25
                                                Total Violations: 17,969,374
                                            Peak Disk Usage (GB): 8.575
                                           Final Disk Usage (GB): 1.668

Efficiency Metrics:
--------------------
                         Longest Command Chain / ICV Elapsed Time: 26%
                        User Time / (#Threads * ICV Elapsed Time): 89%
            Sum of Command User Time / Sum of Command Elapsed Time: 91%
              Sum of Command User Time / Sum of Command Check Time: 93%
           Sum of Command Check Time / Sum of Command Elapsed Time: 98%
                                      Average All-Hosts Memory (GB): 1.72
```

The summary information can also include a Qualitative Analysis section that appears after the Efficiency Metrics section if the tool finds any of the following conditions. Consider the messages in this section first when analyzing the run.

- The number of allocated CPUs exceeds the number of available CPUs on the host
- The amount of memory used on a host exceeds the amount available
- A recommendation to increase or decrease the number of CPUs to optimize efficiency
- Restarted commands exceed one percent of the elapsed time on all hosts
- The log file contains a message about the disk filling up

  If this happens without messages in the log file, the DCV Analyzer tool cannot detect it.

The main part of the report contains a series of tables that show detailed information about specific parts of the run. The number of rows in each table is controlled by the `–c` command-line option. The default is 10.

The report contains two types of tables: command-key tables and grouped-row tables. Command-key tables highlight information about discrete commands and always contain a Command Key column. You can trace the data in this column to a specific instance of a command in the distributed log file. Grouped-row tables contain rows that are grouped for statistical analysis by a common quality, such as input layers or intrinsic types. These rows are aggregates between many commands and cannot be traced to specific instances.

The report contains the following tables:

- Commands sorted by Check Time

  This table shows the discrete commands with the longest check times, as shown in Example 2-6.

Example 2-6 Table Highlighting Information About Discrete Commands

```
Commands sorted by Check Time:
-------------------------------------------------------------------------------------
Check Time User Time Memory  Runset                                           Command
    (min)^     (min)   (GB)  Text                                             Key
       0.3       0.3    0.2  large = external1(lay, distance <= 2 * dist, exte 475.0.0
       0.2       0.2    0.1  internal1(M1, < 0.14, extension = RADIAL, relatio 590.0.0
       0.1       0.2    0.1  m1e2_m1e31_x = enclose_edge(CO, M1, < 0.05, exten 677.0.0
       0.1       0.1    0.1  external1(M1, < 0.14, extension = RADIAL, relatio 591.0.0
       0.1       0.1    0.1  small = external1(lay, distance <= dist, extensio 474.0.0
       0.1       0.1    0.1  via1e21_y = enclose_edge(VIA1, M1, < 0.05, extens 687.0.0
       0.1       0.1    0.1  m1e2_m1e32_y = touching_edge(CO, m1e2_m1e31_x)    680.0.0
       0.1       0.1    0.1  -=_read_library_segment Intrinsic, RunsetText N/A 297.0.0
       0.1       0.1    0.1  output = internal_corner1(red, distance < 3.0, ty 482.0.0
       0.0       0.0    0.1  M2 = assign({ { 12 } })                           358.0.0
-------------------------------------------------------------------------------------
```

- Commands sorted by User Time

  This table shows the discrete commands with the longest user times.

- Commands sorted by Memory

  This table shows the discrete commands with the highest peak memory.

- Commands sorted by Work

  This table shows the discrete commands that use the largest combination of peak memory and user time. These commands use the most overall computer resources.

  ```
  Work = peak memory * user time
  ```

- Commands sorted by Gain

  This table shows commands in which the amount of output shapes have the largest proportional increase from the amount of input shapes to the command:

  ```
  Gain = Output-Objects / Input-Objects
  ```

  Downstream User Time is the amount of CPU time consumed by all commands that depend on the command in question. This is also expressed as a percentage of the Total User Time of the run.

- Error-Producing Commands sorted by Violation Count

  This table shows the error-producing commands that report the most violations based on the distributed log file. Because of hierarchy or error limit settings, the counts in this table might not match the counts in the *cell*.LAYOUT_ERRORS file. The long-pole times represent the slowest path through the dependent commands for each rule.

- Dangling Commands sorted by Long Pole Time

  This table shows the dangling commands, which are commands that do not have child commands and are not producing a violation comment or creating any data. Ideally, this table should not appear because these commands should be optimized away.

- Error-Producing Commands sorted by Long-Pole Time

  This table shows the error-producing commands that cause the run to go the slowest.

  Upstream User Time shows the total amount of CPU power required to process all the dependencies of the rule.

  Restarted Commands shows commands that the tool had to stop and restart in the given long-pole chain, most likely due to memory contention on the host, which the command started. Commands that are restarted retain the same command key.

- Data-Creating Commands sorted by Long-Pole Time

  This table shows the data-creating commands, which are commands without a violation comment that write a file to the output directory. This file can be a layout file, a database for the Synopsys StarRC™ tool, or an intermediate file for an LVS run.

- Error-Producing Commands sorted by Maximum Memory

  This table shows which error-producing commands have commands in their paths that consume the most memory.

- Slowest User Functions sorted by User Time
  Slowest User Functions sorted by Elapsed Time

  These two tables group runtimes by custom PXL functions defined in the runset. The tool sorts the tables based on the times used to group user functions defined by the runset coder. One table is sorted by the CPU (user) time; the other table is sorted by the elapsed time.

  The `DCV_USER_FUNCTION_LOOPS` and `DCV_USER_FUNCTION_VALUES` environment variables control how the information is displayed, and how they are printed in the footer of the each table. For more information, see "Environment Variables" on page 2-6. By default, nested user functions show discrete numbers, not cumulative numbers. In other words, if user function A contains user function B, the effects of the IC Validator intrinsics in function B are not cumulative for the report of function A. The numbers indicate which line of the runset they come from.

For information about limitations and deciphering the function name, see "User-Functions File" on page 2-18.

The Memory Stats section of the report shows all of the commands that ran for each host when the host reached its peak memory.

Runset and input database MD5 checksums are tracked by the DCV Analyzer tool. This data is useful when you compare multiple runs to determine if the runset or input data has changed. If the checksums match, the input data is identical. If the checksums do not match, they are most likely different, although the manner in which they have changed may or may not be pertinent to the analysis that is being performed.

For all IC Validator runs using version M-2017.06 or later, runset checksums are printed for each file in the runset as well as a total checksum for all of the files in the runset.

The runset checksum is sensitive to changes in any evaluated IC Validator logic, and it changes with environment variables that are referenced in the PXL file. The runset checksum is insensitive to comments and whites-space changes.

Additionally, if the runset is configured using `run_options(report_streamfile_information={MD5SUM})` or the `-rsi MD5SUM` command-line option, the input GDSII or OASIS database checksum information is printed.

User-Functions File

The user-functions file, userfunction_summary.txt, contains detailed information about the user functions contained in the file. You can control how this information is displayed by using the `DCV_USER_FUNCTION_LOOPS` and `DCV_USER_FUNCTION_VALUES` environment variables. For more information, see "Environment Variables" on page 2-6.

Limitation:

The use of encryption or the published keyword in the runset obfuscates details in the distributed log file, and the DCV Analyzer tool is unable to present all of the information.

The file shows the hierarchy of all user functions contained within a runset. Each row shows statistical information for all native intrinsics in a user function. To get totals, you must manually add the nested functions to the level of interest. The format is

```
function_name@runset_file_name:line_number.loop_iteration
```

Table Report Files

The table report files, named *table-name*_table.tsv, contain raw data from the database tables used for all of the queries. These files are meant to be used only for debugging or advanced analysis. You can import these tab-separated values files into the Microsoft Excel tool.

Command Chain and Full History Files

The command chain files show the longest serial path of dependencies to reach a given command key. The full history files show every command that was executed (in order) to reach the command of interest (superset of equivalent command chain file). For each command, these dependencies include

- Elapsed time
- Gap time (present only in the command chain files)

  The gap time is the start time of the current command minus the end time of the previous command. For the first command, the gap time is the same as the start time because the previous end time is 0.
- Memory the command used
- Total of all the output geometric objects and the associated gain

The runset text, truncated at 75 characters with an ellipsis (...), and the parent command keys for each command in the chain appear on the right side of the report. Consider that input counts come from alternate parent commands, which are listed, and not just from the previous command key listed in the file. If you are interested in a parent command, you can regenerate its equivalent file by using the `–r` and `–l` command-line options in a subsequent run. The bottom of the file provides statistical information relative to the chain.

Example 2-7 shows an example of a command chain file.

Example 2-7 Command Chain File Example

```
Command    Elapsed Gap Time Memory       Output Gain Runset                   Parent
   Keys Time (min)    (min)   (GB) Object Count      Text                 Command Keys
297.0.0       4.21     0.08   0.31            0    0 -=_read_library_segment
                                                     Intrinsic, RunsetText N/A=
301.0.0       0.38     0.00   0.62            0    0 -=_create_hierarchy_tree
                                                     Intrinsic, RunsetText N/A=-
                                                                               297.0.0
355.0.0       2.77     0.16   0.75   30,222,080 +INF M1 = assign({ { 11 } })
                                                                       301.0.0 297.0.0
356.0.0       0.53     6.05   0.30   30,236,670 1.00 M1 = assign({ { 11 } })
                                                                       355.0.0 320.0.0
416.0.0       1.07     1.69   0.53      242,374 0.00 Generating associated layer
                                                     temp.associated
                                                                       386.0.0 383.0.0
                                                                       323.0.0 356.0.0
694.0.0      11.26    10.17   2.07  121,741,385 1.57 m1e2_m1e31_x = enclose_edge(
                                                       CO, M1, < 0.05,
                                                       extension = NONE,
                                                           look_thru ...
                                                                       425.0.0 356.0.0
                                                                       323.0.0 416.0.0
                                                                               383.0.0
696.0.0       0.74    10.96   0.71      186,539 0.00 Generating associated layer
                                                     m1e2_m1e32_y.associated
                                                                       694.0.0 323.0.0
                                                                               383.0.0
697.0.0       5.11     4.12   1.03  121,780,908 0.72 m1e2_m1e32_y =
                                                     touching_edge(
                                                       CO, m1e2_m1e31_x
                                                     )
                                                                       696.0.0 694.0.0
                                                                       695.0.0 323.0.0
                                                                               383.0.0
698.0.0       0.65     0.43   0.53       20,919 0.00 Generating associated layer
                                                     temp.associated
                                                                       697.0.0 323.0.0
699.0.0       0.80     0.00   0.16            0 0.00 length_edge(
                                                       m1e2_m1e32_y, < 0.001
                                                     )
                                                                       697.0.0 323.0.0
                                                                               698.0.0

Sum of Chain Elapsed Times:          27.52  minutes  (includes Restarted Times)
Sum of Chain Gap Times:              33.66  minutes
Sum of Chain Restarted Times:         0.00  minutes
Sum of Chain User Times:             26.17  minutes
```

The data in the command chain file is similar to the data in the summary report file. However, the command chain file is organized by execution time rather than by statistics. Locating issues created by linear dependencies might be easier in this format.

Analyzing and Comparing Hierarchies

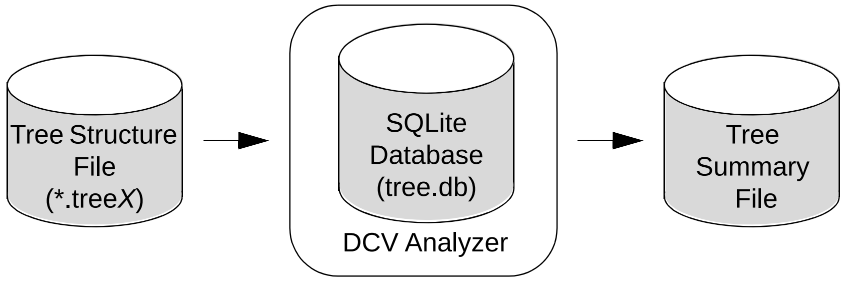
For hierarchy analysis, the DCV Analyzer tool takes input from a tree structure file that you specify and stores the data in an SQLite database, named tree.db, in the current working directory. Then the tool analyzes the hierarchy data and generates reports in the current working directory. By default, the tool provides hierarchy analysis information in a tree summary file named tree_summary.txt.

For example, you can enter the following command:

```
# dcv_analyzer mycell.tree0
```

The tool generates the SQLite database and the tree summary file in the current working directory. Most of the runtime involves creating the SQLite database. For subsequent runs with the same hierarchy data, you can use the `-r` command-line option to reanalyze the data and regenerate or add reports from the same SQLite database. Figure 2-2 illustrates this flow.

Figure 2-2 DCV Analyzer Hierarchy Analysis Flow



The hierarchy analysis operation is independent of the performance analysis operation; you can draw any linkage between the results that you want.

For hierarchy comparisons, the DCV Analyzer tool takes input from two tree structure files that you specify and stores the data in two SQLite databases, named tree.db and tree2.db, in the current working directory. By default, the tool provides the following information:

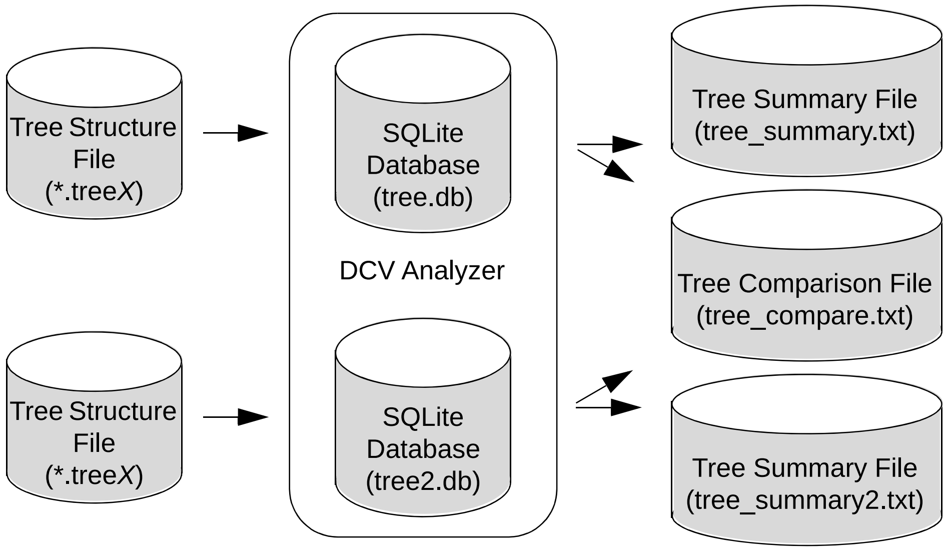
- Hierarchy analysis information in two tree summary files, named tree_summary.txt (from tree.db) and tree_summary2.txt (from tree2.db)
- Hierarchy comparison information in a tree comparison file, named tree_compare.txt, that highlights cross-referenced data between the two tree structure files

The tree structure files do not have to be from the same IC Validator run nor do they have to be of the same type (for example “tree0”). The DCV Analyzer tool can process any two tree structure files. For example, you can enter the following command:

```
# dcv_analyzer mycell.tree0 mycell.tree999
```

The tool generates the SQLite databases and the tree summary files in the current working directory. Most of the runtime involves creating the SQLite databases. For subsequent runs with the same hierarchy data, you can use the `-r` command-line option to reanalyze the data and regenerate or add reports from the same SQLite databases. Figure 2-3 illustrates this flow.

Figure 2-3 DCV Analyzer Hierarchy Comparison Flow


Tree Structure File (*.tree*X*)
SQLite Database (tree.db)
DCV Analyzer
Tree Structure File (*.tree*X*)
SQLite Database (tree2.db)
Tree Summary File (tree_summary.txt)
Tree Comparison File (tree_compare.txt)
Tree Summary File (tree_summary2.txt)

The tool also generates a reference cells file, reference_cells.txt, that compares only the differences found in the Cell Statistics sections of the tree structure files. When the statistics match for a cell, no data for that cell is included in the reference cells file. If the statistics for a cell appear in only one of the tree structure files, the data for that cell is omitted from the reference cells file.

The tool generates additional output files depending on the options that you include on the `dcv_analyzer` command line.

- Cell information files

  If you use the `-C` command-line option to specify a list of cell names, the tool produces a file named cell_*cell-name*.txt for each cell. These files contain statistical information about the cells.

- Layer information files

  If you use the `-L` command-line option to specify a list of layer names or layer number and data type pairs, the tool produces a file named layer_*layer-name*.txt for each layer name and a file named *layer_num*:*data_type*.txt for each layer number and data type pair. These files contain statistical information about the layers.

For more information about these output files, see the following sections:

- Tree Summary Files
- Tree Comparison File
- Cell Information Files
- Layer Information Files

Tree Summary Files

When you specify a single tree structure input file, the DCV Analyzer tool creates a tree summary file named tree_summary.txt. If you specify a second tree structure input file, the tool also creates a file, named tree_summary2.txt, and a tree comparison file, named tree_compare.txt. The tree_summary2.txt file contains the same data for the second tree structure file that tree_summary.txt contains for the first tree structure file. The label "Summary for analysis of ..." appears at the top of each tree summary file to identify which tree structure file the data belongs to. The Design Statistics section in the tree structure file contains data from the header of the tree structure file. Table 2-4 provides definitions of these design statistics.

Table 2-4 Tree Structure Design Statistic Definitions

Statistic	Definition
Hierarchical levels	The number of levels in the design.
Unique cells	The number of unique cells in the design.
Hierarchical placements	The total number of placements (SREFs and AREFs) at each level in the design.
Total design placements	The total number of placements (SREFs and AREFs) in the design.
Exploded references	The total number of exploded references in the design.
Exploded placements	The total number of exploded placements in the design.
Total data count	The total number of all polygons, paths, edges, and rectangles in the design.
SREF placements	The total number of cell references in the design.
AREFs	The total number of array references in the design.
AREF placements	The total number of references in each array reference in the design.

Table 2-4 Tree Structure Design Statistic Definitions (Continued)

Statistic	**Definition**
Data	The number of data primitives in each cell of the design.
Text	The number of text primitives in each cell of the design.
Via	The number of via cells in the design.

Example 2-8 shows an example of the Design Statistics section.

Example 2-8 Design Statistics Section Example

```
Design Statistics:
-----------------
    Hierarchical Levels:  3
           Unique Cells:  25,101
Hierarchical Placements:  54,224,801
Total Design Placements:  54,224,801
    Exploded References:  0
    Exploded Placements:  0
       Total Data Count:  2,276,754,400
        SREF Placements:  54,224,801
                  AREFS:  0
        AREF Placements:  0
                   Data:  330,756,000
                   Text:  335,400
                    Via:  2,500

 Level  Placement Count  Path Count   Unique Cell Count
 -----  ---------------  ----------   -----------------
     0                1           1                   1
     1              100         100                 100
     2       54,224,700      25,000              25,000

 Depth       Cell Count
 -----       ----------
     0           25,000
     1              100
     2                1
```

The Placement Count is the total number of cells placed at each level of hierarchy.

The Path Count is the number of unique paths to a cell. For example, `Top – L1 – L2` counts as one path even if cell L2 is placed 500 times.

The Unique Cell Count is the number of unique cells that appear at each level of hierarchy. For example, suppose the hierarchy has the following tree structure:

```
TOP       Level=0  Count=   1
```

```
  L1A     Level=1  Count=   1
    L2    Level=2  Count= 500
  L1B     Level=1  Count=   1
    L2    Level=2  Count=   1
  L2      Level=1  Count=  10
```

Given this structure, the tree summary file shows the following placement counts:

```
 Level  Placement Count     Path Count   Unique Cell Count
 -----  ---------------     ----------   -----------------
     0                1              1                   1
     1               12              3                   3
     2              510              2                   1
```

Depth is defined as the furthest distance from the leaf cell, which is a cell without child cells. For example, if a design has 10 levels of hierarchy, the top cell always has a depth of 10.

Tree summary files contain the following tables:

- Cells sorted by Total Placements

  This table shows cells that are placed the most times. The placement count is for a specific location in the hierarchy (indicated by the Path), so a cell can appear multiple times in this table.

- Cells sorted by Data

  This table shows cells that contain the most geometric objects (all layers). Text counts are displayed in the table but not included in the sorting.

- Cells sorted by Flat Objects

  This table displays the cells that contribute the most data to the design based on a combination of the number of times they are placed and the amount of geometric objects contained within the cell.

  ```
  Flat Objects = FlatPlacements * (Data + Text)
  ```

- Layers within each Cell sorted by Data

  This table shows the layers by cell that contain the most data. The layer number and data type may not be available for certain data formats.

- Layers sorted by Flat Objects
  Layers sorted by Flat Data
  Layers sorted by Flat Text

  These tables display the layers that contribute the most data to the design based on a combination of the number of times the cells they are in are placed and the amount of geometric objects assigned to that layer.

  ```
  Flat Objects = FlatPlacements * (DataCount + TextCount)
  Flat Data = FlatPlacements * DataCount
  ```

```
Flat Text = FlatPlacements * TextCount
```

Tree Comparison File

When you specify two tree structure input files, the DCV Analyzer tool creates a tree comparison file named tree_compare.txt. You can compare two tree structure files from the same or different IC Validator runs. The format of the tree structure files (Milkyway, NDM, LTL, GDSII, or OASIS) does not matter.

The first two tables in the tree comparison file define the missing cells and extra cells from the second tree structure file, sorted by cell area. By default, only the 10 largest cells are shown, but the table headers indicate the total number of cells. You can use the `–c` command-line option to increase the number of rows in the tables.

Note:
Cells that appear in either the extra cells or missing cells table are not included in the majority of the other tables because they are not in both reports and the tool cannot perform a meaningful comparison.

Many of the tables in the tree comparison file contain the same information as the tables in the tree summary file, with the sorting column presented as a gain comparison from the second input file to the first input file. Because of this switching, the order of the input files on the command line might produce a different set of data for each table. Consider the order carefully before running the tool.

The tree comparison file contains the following tables:

- Matching Cells sorted by Total Placements Gain

  This table calculates the ratio of total placements between the files.

- Matching Cells sorted by Data Gain

  This table calculates the ratio of total data (all layers) within each cell between the files.

- Matching Cells sorted by Flat Objects Gain

  This table shows the ratio of total flat objects in each file.

```
Gain = (FlatPlacements2 * (Data2 + Text2))/( FlatPlacements1 * (Data1 + Text1))
```

- Layers in Matching Cells sorted by Data Difference

  This table shows the data by layer and cell difference between the files. The tool uses the absolute values, so the file order should not affect the results.

- Layers within each Cell sorted by Gain

  This table appears twice and shows the same comparison as the previous table, but with the relative differences rather than the absolute differences. The layer and cell names must be the same in both input files for the comparison to be valid. One copy of the table shows the values of the first file to second file comparison, and the other copy of the table shows the second file to first file comparison.

- Matching Layers Flat Objects sorted by Gain
  Matching Layers Flat Data sorted by Gain
  Matching Layers Flat Text sorted by Gain

  These tables show the gain (Flat Objects2/Flat Objects1) between the files. “Data” and “Text” are substituted for “Objects” in their respective tables.

  ```
  Flat Objects = FlatPlacements * (DataCount + TextCount)
  Flat Data = FlatPlacements * DataCount
  Flat Text = FlatPlacements * TextCount
  ```

- Cells sorted by Placement Difference

  This table shows the absolute difference between the two input files of the flat placement count of each cell. Because the tool uses absolute values, the order of the input does not matter. In addition, the missing and extra cells from the first tables should count as “0” in the calculations for this table.

- Cells with changed Status sorted by Flat Placements

  This tables shows matching cells between the input files in which the status does not match. The order is based on the sum of the number of times the cell is placed in each file.

- Status Changed Summary

  This table shows the number of unique pairs of how the status of a given cell might have changed between the input files.

Cell Information Files

When you use the `–C` command-line option to specify a list of cells, the DCV Analyzer tool creates a report file named cell_*cell-name*.txt for each cell in the cell list. If you specify a cell that is not in the data, the tool produces an empty file that contains only table headings.

If you include a wildcard character (*) to specify multiple cell names, you should enclose the entire argument in quotation marks to avoid having the shell interpret the wildcard character (to include files in the current working directory).

For example, `-C "NAND2X0,M*"` produces a file named cell_NAND2X0.txt and a file for each cell with a name that begins with an uppercase M (the cell names are case-sensitive). In this example, if no cells with a name that starts with M exist, the tool produces only the NAND2X0 file.

Cell information files contain the following sections:

- The first section of the report contains statistics, which are similar to the design statistics in the summary report file.
- The second section compares the layers in each cell and the amount of data and text on each layer. The differences reported in this section account for both text and data.
- The third section shows the names of all the immediate child cells with their placement count and status. In this section, the tool compares and calculates differences as appropriate.
- The final section shows all the available paths to the cell of interest in each file, which helps you to determine the parent cells.

You must specify at least one tree structure input file when you use the `-C` command-line option. The DCV Analyzer tool includes data from the input file in the cell information files. If you specify two tree structure files, the tool includes data from both input files side by side, along with a difference column. Differences can be absolute or relative depending on the data, or just an X for a string comparison (Extents and Status).

Layer Information Files

When you use the `-L` command-line option to specify a list of layers, the DCV Analyzer tool creates a layer information file named layer_*layer-name*.txt for each layer in the layer list. Each file contains a list of cells and the number of geometric objects per cell for that layer.

If you include a wildcard character (*) to specify multiple layer names, you should enclose the entire argument in quotation marks to avoid having the shell interpret the wildcard character (to include files in the current working directory).

You must specify at least one tree structure input file when you use the `-L` command-line option. If you specify two tree structure files, the tool includes two lists of cells in the layer information file, one from each tree structure file.

3

DCV Switch Optimizer Tool

This chapter explains how to run the DCV Switch Optimizer tool and view the reports.

The IC Validator DCV Switch Optimizer tool exercises combinations of runset preprocessor flow control switches to identify possible runtime parse errors.

For more information, see the following sections:

- Overview
- Command-Line Options
- Runset Switch Description File
- Error Output Log Files
- Summary Report File

Overview

Many DRC runsets consist of switch blocks that are complex in nature. The manual process of identifying the necessary switch combinations that exercise the entire runset code and detecting parse errors in the runset is often inefficient.

The DCV Switch Optimizer tool reduces manual intervention and allows you to exercise the entire runset code optimally and qualify a runset free of parse errors. The tool exercises a minimal number of user-defined flow control switch combinations to identify possible runtime parse errors. This contrasts with manual runset validation processes that can be error prone (unexpected combinations) or overly conservative, resulting in more runset parse-testing iterations than necessary.

The DCV Switch Optimizer tool takes input from a DRC runset file and produces a log file for each failed parse iteration and a summary report file. The tool scans the runset file to identify all of the switches present in the runset and identifies the minimal set of switch combinations that fully exercise all of the code in the runset.

The tool can also take input from an optional runset switch description file. You should provide this file if the runset contains any of the following special switch types:

- Mutually exclusive switch cases
- Default and default list switch cases
- Ignore switch cases

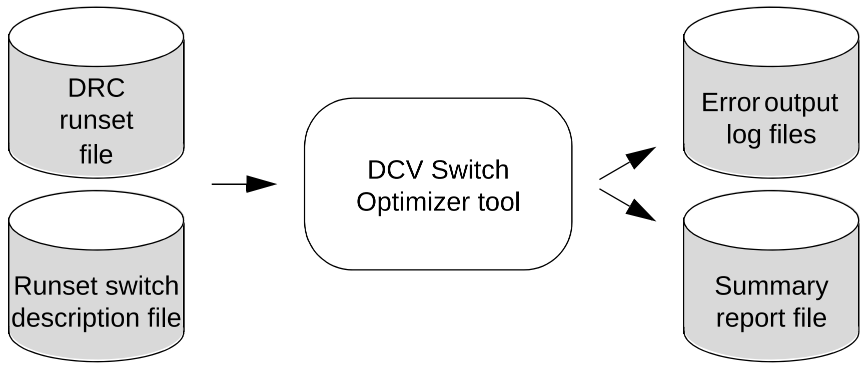
For more information, see “Runset Switch Description File” on page 3-4.

The DCV Switch Optimizer tool performs the following tasks:

1. Examines the entire runset and identify all code blocks and the switches or switch combinations that exercise all code
2. Determines the minimum set of switch combinations that fully cover the runset code
3. Runs IC Validator iteratively with each set of switch combinations

Figure 3-1 illustrates this flow.

Figure 3-1 DCV Switch Optimizer Tool Flows



Command-Line Options

The DCV Switch Optimizer tool command-line syntax is

```
dcv_swop runset-file [command-line-options]
```

where `runset-file` specifies the DCV runset file.

Table 3-1 describes the command-line options.

Table 3-1 DCV Switch Optimizer Tool Command-Line Options

Argument	Description
`-h` `-help`	Displays the usage message and exits.
`-i` `-input`	Specifies the path to the runset switch description file.

Table 3-1 DCV Switch Optimizer Tool Command-Line Options (Continued)

Argument	Description
`-I` *`path`*	Specifies the preprocessor include directories. This command-line option takes only one path, but you can use multiple `-I` options on a command line. When you specify multiple paths, order matters. For example, you have the file aaa.rh in both my_path1 and my_path2. • When you specify `-I my_path1 -I my_path2`, the aaa.rh file from my_path1 is used. • When you specify `-I my_path2 -I my_path1`, the aaa.rh file from my_path2 is used. Include directories are searched after the current working directory is searched. If an include directory is not in the install directory, then for the `-I` command-line option, you must specify the absolute path of the directory.
`-V` `-version`	Prints the tool version.

Runset Switch Description File

The DCV Switch Optimizer tool takes input from a DRC runset file and an optional runset switch description file. You should provide a runset switch description file as input if the DRC runset file contains any special switch types.

For example, to specify mutually exclusive switch types, assume that you have the following switches:

```
SwitchA
SwitchB
SwitchC
SwitchD
SwitchE
SwitchF
SwitchG
SwitchH = dx_YES
SwitchI
SwitchJ = dx_NO
```

These switches have the following mutually exclusive conditions:

- `SwitchA`, `SwitchB`, and `SwitchC` are mutually exclusive with each other

- `SwitchB` is mutually exclusive with `SwitchD` and `SwitchE`
- `SwitchE` and `SwitchF` are mutually exclusive with each other
- `SwitchG` is mutually exclusive with `SwitchI` and `SwitchH = dx_YES`
- `SwitchH = dx_YES` and `SwitchJ = dx_NO` are mutually exclusive with each other

Use the following format to describe these mutually exclusive switch conditions:

```
#MUTEX START
       SwitchA {SwitchB, SwitchC}
       SwitchB {SwitchD}
       SwitchB {SwitchE}
       SwitchE {SwitchF}
       SwitchG {SwitchI, SwitchH = dx_YES}
       SwitchH = dx_YES {SwitchJ = dx_NO}
#MUTEX END
```

Note:
The switches within curly braces should always be on the same line in the runset switch description file.

For more information about the special switch types that you can describe in this file, see the following sections:

- Mutually Exclusive Switch Cases
- Default and Default List Switch Cases
- Ignore Switch Cases

Mutually Exclusive Switch Cases

Use the mutually exclusive switch case to identify switches and values that should not be allowed at the same time. For example, if the following switches are turned on at the same time, a parse error results:

```
#ifdef LAYOUT_FORMAT_GDS
   aFFO = assign ( {{ 1, 0 }} );
#endif

#ifdef LAYOUT_FORMAT_OASIS
   aFFO = assign ( {{ 100, 0 }} );
#endif
```

You can avoid having to specify mutually-exclusive switches in the runset switch description file by adding an error detection case. For example:

```
#ifdef LAYOUT_FORMAT_GDS
   #ifdef LAYOUT_FORMAT_OASIS
```

```
      #error “Can’t do this”
   #endif
#endif
```

The DCV Switch Optimizer tool automatically detects these error cases and prevents corresponding switches from being active at the same time.

Default and Default List Switch Cases

Use the default switch case to identify switches that must be set to some value every time the runset is used. These switches fall into one of the following categories:

- Single default value
- List of default values

Single default value switches must be set to a specific value for every parser iteration. This is typically done to establish a known startup state and is not meant to be modified by the runset users. For example:

```
#DEFAULT START
ABC = ON
FFO = ON
BRR = TOT
PQR = OFF

#DEFAULT END
```

The result is a runset with the following switch settings for each parser iteration:

- `#define ABC`
- `#define FFO`
- `#define BRR TOT`
- `#undef PQR`

Note:
You do not need to specify entries for `#define` statements used to set variables to a specific value (for example, macro expansions).

Switches that use a list of default values must be set to a value for every parser iteration, and each value must come from a defined list of valid choices. The DCV Switch Optimizer tool chooses a random value from the list and sets the switch accordingly. A new value is chosen for every parser iteration. For example:

```
#DEFAULT START
ABC = {value_1, value_2, value_3}
#DEFAULT END
```

If you specify either an invalid value or a missing value for the default list of switches in the user-input file, the tool reports a warning message to STDOUT. For example:

```
WARNING: Invalid value(s) specified.
         Please check the <user-input> file.
         Switch = PQR , Value = GREEN
         Switch = ABC , Value = RED

WARNING: Missing value(s) detected for the following switch(es).
         Please check the <user-input> file.
         Switch = PQR, Value = BAR
         Switch = ABC , Value = BLUE
         Switch = ABC , Value = FOO
```

Ignore Switch Cases

The ignore switch case refers to switches that are to be left alone by the DCV Switch Optimizer tool. These switch settings, and their resulting behavior, are left as coded in the original runset.

This type of switch can be used to control the inclusion of control of the inclusion of common blocks of PXL code, as shown by the following example:

```
#ifndef ASSIGN_RS
        #include assign.rs
        #define ASSIGN_RS
#endif
```

In this example, the `ASSIGN_RS` switch is used to make sure that the assign.rs file is included only one time. This coding style relies on the switch not being turned on at the start.

If the DCV Switch Optimizer tool tries to set the `ASSIGN_RS` switch to `ON` as part of testing all of the runset code blocks, the assign.rs file are not included. This results in a parse error because the layers that the tool expects subsequent code to define in the file are not be created.

Example 3-1 Ignore Syntax Example

```
#IGNORE START
ASSIGN_RS
#IGNORE END
```

Note:

An alternative way to handle this example is to use the Single Value Default case to set `ASSIGN_RS` to `OFF`.

```
#DEFAULT START
ASSIGN_RS = OFF
#DEFAULT END
```

Error Output Log Files

When the DCV Switch Optimizer tool identifies a set of switch options that produces a parse error, the tool produces an error log file. This file contains the IC Validator output for the run and describes why the iteration failed. The DCV Switch Optimizer tool creates an error log file for each iteration that has a parse error. The file names have the format ParserIteration_*number*.log, where *number* is the parser iteration number where the error occurs.

Summary Report File

The tool produces a report file that summarizes all of the parser iterations. The report contains the following information:

- Total number of iterations required to cover the entire runset code
- Results of all of the parser iterations
- Detailed descriptions of iterations that result in a parse error

The report includes the following sections:

- Parser Results Summary

  This section lists the parser iteration numbers and results. The results are either PASS or FAIL. For failed parser iterations, the report also includes the path to the iteration-specific log file.

  The following example lists a parser iteration that failed and a parser iteration that passed:

```
Parser Iteration 1: FAIL - Check ParserIteration_1.log file for more info...
Parser Iteration 2: PASS
```

- Parser Results Details

  This section contains a detailed description of any iteration that results in a parse error. This information includes the specific switch settings corresponding to the failed parser iteration, a Pass or Fail indicator, and the IC Validator command-line call that produces the parse failure.

  The following example shows the description of a parser iteration that failed:

```
#########################
# Parser Iteration 1    #
#########################
TURN ON:
    d_11M_3MX_4FX_2HX_2GX_LB__R0
TURN OFF:
    d_CELL_FINE_SS_YES
Switch Values:
    d__SRULES_MERGED = dx_NO
RESULT: FAIL
ICV Called as: icv -nro -c a -i /remote/us54home1/user/empty_test.gds
-D d_11M_3MX_4FX_2HX_2GX_LB__R0
-D d__SRULES_MERGED=dx_NO /remote/us54home1/user/runset/runset.rs
```

Example 3-2 shows an example of a DCV Switch Optimizer report file.

Example 3-2 DCV Switch Optimizer Report File

```
Runset Switch Combinations - Parser Results Summary
===================================================

Total Iterations Required: 6

Results:
--------
Parser Iteration 1 : FAIL - Check ParserIteration_1.log file for more info...
Parser Iteration 2 : PASS
Parser Iteration 3 : PASS
Parser Iteration 4 : PASS
Parser Iteration 5 : PASS
Parser Iteration 6 : PASS


Runset Switch Combinations - Parse Results Details
===================================================

###########################
# Switch Combination 1 :  #
###########################

TURN ON :

       SWITCH_ABC
       SWITCH_CDE
       SWITCH_PQR
       SWITCH_XYZ

TURN OFF :

       SWITCH_LMN
       SWITCH_FFO




Switch Values:

       SWITCH_BRR = Mx_NO
       SWITCH_TOT = Mx_YES

ICV Called as : icv –nro –c swop_test_top_cell –i /Path/to/the/dcv_swop_test.gds –D
SWITCH_ABC –D SWITCH_CDE –D SWITCH_PQR –D SWITCH_XYZ –D SWITCH_BRR = Mx_NO –D
SWITCH_TOT = Mx_YES  /path/to/the/runset.rs
```

```
RESULT: FAIL
```

.STATs File

The tool generates a SwOP_*runset_name*.STATS file that contains the runset parser iteration statistics.

Example 3-3 shows an example of a DCV Switch Optimizer .STATs file.

Example 3-3 DCV Switch Optimizer .STATS File

```
-------------------------------------------------------------------------------
                                 DCV Switch Optimizer

                 Version M-2016.12 for linux64 - Nov 18, 2016 cl#3444454

                         Copyright (c) 2014 - 2016 Synopsys, Inc.

                            Runset Parse Iteration Statistics
-------------------------------------------------------------------------------


Total number of unique switches         = 4

Number of #ifdefs                       = 2

Number of #ifndefs                      = 1

Number of #if                           = 1

Exhaustive number of switch combinations = 16

Optimized set of switch combinations     = 2

Optimization                            = 87.50 % reduction
```

4

DCV Results Compare Tool

This chapter explains how to run the DCV Results Compare tool and view the reports.

The IC Validator DCV Results Compare tool compares two sets of error data from different sources and produces a prioritized discrepancy report, and output that you can view in the IC Validator VUE tool.

For information about this tool, see the following sections:

- Overview
  - DRC
  - LVS
- Command-Line Options
- DRC Results Comparison
- LVS Results Comparison
- Waiver Conversion Flow

Overview

DRC

You can use the DCV Results Compare tool to compare the results from different IC Validator runs or to compare IC Validator results with the results from a third-party tool. Performing such comparisons manually can be a tedious, error-prone process. Although the IC Validator LVL tool can compare two layouts, only the DCV Results Compare tool provides an error-versus-error comparison for runset results.

The DCV Results Compare tool performs an automated results-versus-results comparison using error results as input. To run the tool, you must specify the comparison type, the baseline and comparator results, and the layout data. You choose the type of comparison to be made and the input formats for the error results and layout data.

The comparison type controls the nature of the comparison. Depending on the comparison type that you specify, the tool can report discrepancies if the error markers do not

- Match exactly
- Match exactly within an expanded region
- Overlap except for an edge abutment or corner touch
- Overlap except for a corner touch
- Overlap at all

The DCV Results Compare tool automatically detects the input formats of the error results and layout data.

- The baseline results are the error markers that the tool uses as reference data.
- The comparator results are the error markers that you want to compare against the reference data.
- The layout data can be the original layout database that you used to generate the error results or a skeleton database that contains just the layout hierarchy data.

This input data can have different formats. Error results can be in an IC Validator error file, a PYDB database, an OASIS file, a GDSII file, a third-party ASCII error file, or a DCV internal error format file. The layout data can be in an OASIS file or a GDSII file.

By default, the results comparison is a one-to-one mapping based on matching rule names. You can specify custom rule mappings by creating an input rule-map file or by editing the optional default rule-map file that the tool creates.

The tool can also generate a default rule-map file that you can modify and use as input for a subsequent run.

You can select a subset of rules to use during a run by including or excluding individual rule groups defined in the rule-map file.

You can also set waivers that prevent the tool from reporting known results comparison discrepancies by specifying an error classification database. The tool marks these waived discrepancies in the reports that it generates. The tool limits waiver usage to approved results.

The DCV Results Compare tool produces a comparison report that summarize the details of how the comparator results correlate with the baseline results. The report contains a report header, a comparison summary, and detailed comparison results.

LVS

You can use the DCV Results Compare tool to compare the results from different IC Validator LVS runs. Performing such comparisons manually can be a tedious, error-prone process if the number of equivalence points is large. Both the extraction and compare stage results can be compared by the DCV Results Compare tool.

The DCV Results Compare tool performs an automated results-versus-result comparison using LVS run results as input. The comparison of LVS results can be separated into two components, comparison of the extraction stage results and comparison of compare stage results. To run the tool, you must specify the correct input data for either the extraction stage or the comparison stage.

The extraction stage results comparison uses the same input as the DRC flow. The one difference is that LVS extraction stage comparison will use the “exact” mode of comparison, regardless of what is specified on the command line. This compare stage is required as an input for IC Validator functions other than text related and device extraction functions.

For the LVS compare stage results comparison, you can specify the run directories for baseline and comparator LVS runs.

The DCV Results Compare tool automatically detects the input formats of the error results. For the extraction stage, the comparison is a one-to-one mapping based on matching IC Validator functions. Duplicate functions are paired by their order of appearance in runset. The compare stage results comparison is based on equivalence points, and the compare results is an overview of mismatched attributes. The error details are not currently compared.

Command-Line Options

Before running the DCV Results Compare tool, make sure your `LM_LICENSE_FILE` and `ICV_HOME_DIR` environment variables are set. The `dcv_rct` executable is located in the same bin directory as the `icv` executable. The tool creates the output database and report files in your current working directory.

The DCV Results Compare tool command-line syntax is

```
dcv_rct
    [options]
    overlap | exact | fuzzy_exact
    baseline_data
    comparator_data
    layout_data
```

where

- *`baseline_data`* specifies the results file that contains the reference error data
- *`comparator_data`* specifies the error file that contains the error data for comparison with the reference error data
- *`layout_data`* specifies either the original layout database used to generate the error data or a skeleton database that contains just the layout hierarchy data

Table 4-1 describes the command-line options.

Table 4-1 DCV Results Compare Tool Command-Line Options

Option	Description
`-all_rules`	Disables rule filtering. By default, the tool excludes rules from the rule map file for which the baseline and comparator data contain no violations and does not include these rules in the output report.
`-convert`	Converts error data from any supported input format to the internal DCV error map format.
`-cpydb_name` *`error-db`*	Specifies the name of the error classification database (cPYDB) that contains error waivers. You must use the `-cpydb_path` option to specify the path to the database.
`-cpydb_path` *`path-name`*	Specifies the path to the error classification database (cPYDB) that contains waivers for comparison discrepancies. You must also use the `-cpydb_name` option to specify the name of the database.

Table 4-1 DCV Results Compare Tool Command-Line Options (Continued)

Option	Description
`-csv`	Saves the summary report in a comma separated value (CSV) format file, in addition to the comparison report file. You can import this CSV file into a third-party tool, for further analysis.
`-dbname` *`database`*	Specifies the error database (PYDB) that the tool reads for error input.
`-delta` *`value`*	Specifies the tolerance that the tool uses to expand the baseline and comparator data for the `fuzzy_exact` comparison type. The tool uses this value as a multiplier of the input database resolution. The maximum value is `10`. The default is `5`.
`-dp`*`#_of_hosts`*	Enables a distributed run using the specified number of distributed processing hosts, all running on the local host. For example, `-dp4` specifies four hosts. The default is two hosts, `-dp2`, using only as many processors as there are distributed processing clients on a machine for dynamic threading. If you want to use all of the processors on the machines for dynamic threading, use the `-turbo` option. For more information about distributed processing, see the *IC Validator User Guide*.
`-g`	Generates a rule-map file containing default rules that you can modify and use as input for a subsequent run. The tool determines these default rules based on the data it is comparing when you do not specify an input rule-map file with the `-m` option.
`-h` `-help`	Displays the usage message and exits.

`-i edge | all`
`-include edge | all`
	Specifies the types of error marker interactions that represent a match when you specify the `overlap` comparison type. By default, the tool reports discrepancies for error markers that do not interact in any way. Use `edge` to report discrepancies for error markers that do not interact except for edge abutments or point touches. Use `all` to report discrepancies for error markers that do not interact except for point touches only.

Table 4-1 DCV Results Compare Tool Command-Line Options (Continued)

Option	Description

`-lvs`	Executes the LVS compare stage results comparison flow. The syntax is:
	`dcv_rct -lvs baseline_input_directory`
	`   comparator_input_directory`
	
	The input directory is the run_details directory from the original IC Validator run without modification.

`-m` *`map-file`*
`-map` *`map-file`*
	Specifies a rule-map file containing the rules that the tool uses to compare results. If you do not specify this file, the tool determines default rules based on the data it is comparing. To generates a default rule-map file that you can modify and use for subsequent runs, specify the `-g` option.

`-missing_rules`	Explicitly identifies rules that are present in one input, but are completely absent from the other. By default, the DCV Results Compare tool identifies these missing rules in the regular summary with a RCT_gen* prefix. This command-line option creates two additional sections in the report identifying all missing rules by their original name. See Example 4-5 for more information. Note: The `-missing_rules` command-line option is ignored for GDSII or OASIS inputs.
`-skeleton`	Creates a layout database that contains only the layout hierarchy data from the original layout database, which is required input when you use this option. For subsequent runs, you can specify this skeleton layout database as input instead of the original layout database.
`-srg` *`rule-group-list`*	Specifies one or more rule groups, from the rule-map file, that the tool uses to compare the results. Separate individual rule groups with commas.

Table 4-1 DCV Results Compare Tool Command-Line Options (Continued)

Option	Description
`-svc`	Selects by rule names from either the baseline or the comparator inputs. The arguments • Can include the wildcard * and range expressions using [ ]. • Must be enclosed in quotation marks if it uses a wildcard *. (This enclosure prevents processing by the UNIX shell.) These options take only one argument but you can specify multiple options on a command line. For example, `% dcv_rct -svc "*96A1*" -svc "*11B16*"` • If the selection option is not used for a category but the suppression option is used, then all violations excluding those suppressed are selected for that category. • If the final selection of violations is empty, the run terminates with an error. Usage of the `-svc` and `-uvc` command-line options is allowed only when the baseline/comparator formats are text based or PYDB based.
`-turbo`	Allows the tool to use all of the processors on the machines for dynamic threading. If you do not use this option, the tool can use only as many processors as there are distributed processing clients on a machine for dynamic threading.
`-urg` *`rule-group-list`*	Specifies one or more rule groups, from the rule-map file, that the tool excludes from the results comparison. Separate individual rule groups with commas.
`-uvc`	Suppresses by rule names from either the baseline or the comparator inputs. See the `-svc` command-line option for more information.

DRC Results Comparison

Running the Tool

The DCV Results Compare tool compares errors from two data files and reports discrepancies based on the comparison type that you specify. The tool also provides command-line options that you can use to

- Specify custom rule mappings in a rule-map file
- Select rules that you want to include or exclude

- Waive individual discrepancies by specifying an error classification database

To compare error data, you specify the type of comparison you want to perform, the files that contain the errors you want to compare, and the layout data. For example, to compare the results from a baseline file named TOP.LAYOUT_ERRORS and a comparator file named TOP.db with the original layout data in a file named TOP_input.gds, and report discrepancies for errors that do not match exactly, enter

```
% dcv_rct exact TOP.LAYOUT_ERRORS TOP.db TOP_input.gds
```

The available comparison types are `overlap`, `exact`, and `fuzzy_exact`. For more information, see "Setting the Comparison Type" on page 4-8. For information about the file formats for the input files, see "Input File Formats" on page 4-10.

You can specify either the original layout database used to generate the results or a skeleton database that contains just the layout hierarchy data. The tool uses this data to resolve hierarchical differences in the output results if either the baseline or comparator results are in a text file format.

The DCV Results Compare tool performs a rule-based error-versus-error comparison of the error data and creates a comparison report listing the discrepancies sorted by severity. The tool generates both a report file, *top_cell*.RCT.report, and a VUE-compatible file, *top_cell*.RCT.vue, where *top_cell* is the name of the top cell in the design.

You can also save the report in a comma-separated value (CSV) format file by using the `-csv` command-line option. You can import this file into a third-party tool (such as the Microsoft Excel tool) for further analysis.

For information about the report file, see "Comparison Results File" on page 4-16. For information about the IC Validator VUE tool, see the *IC Validator VUE User Guide*.

For more information, see the following sections:

- Specifying Custom Rule Mappings
- Including or Excluding Rules
- Waiving Errors With an Error Classification Database

Setting the Comparison Type

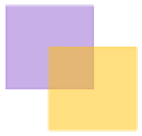
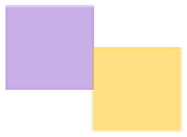
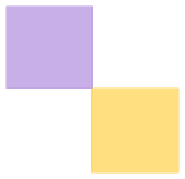
The comparison type sets the criteria for matches between baseline and comparator error markers. Valid comparison types are `overlap`, `exact`, or `fuzzy_exact`. The tool performs an automated results-versus-results comparison of the error data and reports PASS for errors that match and FAIL for errors that fail the comparison.

Use `overlap` to match error markers that overlap. You can include edge abutments and corner touches by using the -i command-line option.

- To report a match for error markers that have an edge abutment or a corner touch but do not overlap, use the `-i edge` command-line option.
- To report a match for error markers that have a corner touch but do not overlap or have an edge abutment, use the `-i all` command-line option.

Table 4-2 shows the truth tables for the `overlap` comparison type.

Table 4-2 Interactive Matches

Comparison type	**Overlap** 	**Edge abutment** 	**Point touch** 
`overlap`	PASS	FAIL	FAIL
`overlap -i edge`	PASS	PASS	FAIL
`overlap -i all`	PASS	PASS	PASS

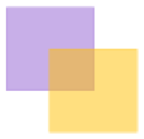
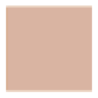
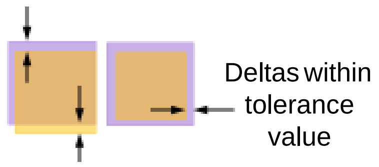
Use `exact` to match error markers that match exactly.

Use `fuzzy_exact` to match error markers that match exactly within an expanded region. You can define a tolerance value for this region by using the `-delta` command-line option to specify a multiplier of the input database resolution. The maximum value is `10`. The default is `5`.

For example, if the input database resolution is 0.001 um, the default tolerance value for the expanded region is 0.005 um. The tool expands the error markers from the baseline and comparator data, and then evaluates them to determine if they match within these expanded regions.

Table 4-3 shows the truth tables for the `exact` and `fuzzy_exact` comparison types.

Table 4-3 Exact Matches

Comparison type	**Overlap**	**Exact**	**Fuzzy exact**
			
`exact`	FAIL	PASS	FAIL
`fuzzy_exact`	FAIL	PASS	PASS

Input File Formats

The Results Compare tool automatically detects the input data formats. The baseline and comparator data do not have to be in the same format. The valid formats for the baseline and comparator data files are

- IC Validator LAYOUT_ERRORS file
- IC Validator error database (PYDB)
- DCV error map database
- GDSII
- OASIS
- Third-party ASCII error file

Note:
When the baseline or comparator data is in the IC Validator error database format, use the `-dbname` command-line option to specify the PYDB file name.

The input data does not need to be flattened because the tool preserves the hierarchy of the input data during a comparison.

The valid formats for the original layout data file are

- GDSII
- OASIS

Note:
For text-based comparison, at least one of the error formats (baseline or comparator) must be of the following type:

- IC Validator ASCII error format
- IC Validator PYDB error format
- DCV error map format

Specifying Custom Rule Mappings

By default, the DCV Results Compare tool creates rule mappings based on a 1:1 correspondence of matching rule names extracted from the baseline and comparator error input. These default 1:1 rule mappings are sometimes inadequate. For example, you might need to map multiple rules together in an *N*:1, 1:*M*, or *N*:*M* mapping. You might also encounter cases where rule names do not match and the tool creates placeholder rule names.

You can provide customized rule mappings in a rule-map file, which you specify by using the `-m` command-line option. For example, to specify a rule-map file named TOP.RCT.rule_map, enter

```
% dcv_rct -m TOP.RCT.rule_map exact TOP.LAYOUT_ERRORS TOP.db TOP_input.gds
```

The tool generates a default rule-map file when you use the `-g` command-line option. You can modify this file and use it as input in a subsequent run. Use this option if you know in advance that the default 1:1 rule mappings are inadequate.

```
% dcv_rct -g exact TOP.LAYOUT_ERRORS TOP.db TOP_input.gds
```

For more information about rule-map files, see “Rule-Map File” on page 4-12.

Including or Excluding Rules

You can limit the comparison to a subset of the available rules by adding rules to an empty selection or by subtracting rules from a universal selection. You specify the rules by using their group identifiers in the rule-map file. The tool selects the entire rule group associated with an identifier to ensure a correct comparison.

To include rules, use the `-srg` command-line option to specify the rules or rule groups. For example, to use only rule groups 1, 2, and 4, enter

```
% dcv_rct -m TOP.RCT.rule_map -srg 1,2,4 exact TOP.LAYOUT_ERRORS TOP.db TOP_input.gds
```

To exclude rules, use the `-urg` command-line option to specify the rules or rule groups. For example, to exclude rule groups 2 and 5, enter

```
% dcv_rct -m TOP.RCT.rule_map -urg 2,5 exact TOP.LAYOUT_ERRORS TOP.db TOP_input.gds
```

The Results Compare tool automatically filters rules for which the data does not contain violations by default. To disable filtering, use the `-all_rules` command-line option.

```
% dcv_rct -all_rules exact TOP.LAYOUT_ERRORS TOP.db TOP_input.gds
```

Waiving Errors With an Error Classification Database

The DCV Results Compare tool allows you to specify waivers in an error classification database that prevent the tool from reporting known results comparison discrepancies. The tool marks these waived discrepancies in the reports.

To specify the error classification database (cPYDB), use the `-cpydb_name` and `-cpydb_path` command-line options.

Error classification for the DCV Results Compare tool is similar to the IC Validator error classification flow. The only difference is that you specify the error classification database on the DCV Results Compare tool command line by using the `-cpydb_name` and `-cpydb_path` options.

In general, follow these steps to set waivers for comparison discrepancies:

1. Run the DCV Results Compare tool on the input error data and layout data.
2. Classify the comparison discrepancies that you want to waive and save them in an error classification (cPYDB) database by using the IC Validator VUE tool or the pydb_report utility.

   You can merge new classifications into an existing error classification database. The tool appends the newly classified errors to the database and updates existing errors that have changed.

   For more information about classifying errors, see the *IC Validator VUE User Guide*. For information about error classification databases, see the *IC Validator User Guide*.
3. Rerun the DCV Results Compare tool with the error classification database to preclassify the discrepancies.

   Use the `-cpydb_name` and `-cpydb_path` command-line options to specify the name and location of the error classification database.

Rule-Map File

The rule-map file specifies how the DCV Results Compare tool compares the baseline and comparator error input. By default, the tool uses a 1:1 mapping based on matching rule identifier names. The rule-map file consists of six comma-separated fields. Table 4-4 describes these fields.

Table 4-4 Fields in a Rule-Map File

Field	Description
Rule group ID	Defines the correspondence between the baseline and comparator results to be compared. The results from rules that contain the same rule group ID are merged for comparison.

Table 4-4 Fields in a Rule-Map File (Continued)

Field	Description
Baseline rule identifier	Identifies the process ground rule from the baseline results, for example, GRMx.S.2.
Baseline (*layer*;*datatype*)	Identifies the baseline *layer*;*datatype* assigned for the generation (default case) of the baseline error shapes. For GDSII or OASIS error files, this data corresponds to the *layer*;*datatype* assigned to the error output.
Comparator rule identifier	Identifies the process ground rule from the comparator results, for example, GR.Mx.S.2.
Comparator (*layer*;*datatype*)	Identifies the *layer*;*datatype* assigned for the generation (default case) of the comparator error shapes. For GDSII or OASIS error files, this data corresponds to the *layer*;*datatype* assigned to the error output.
Description	Identifies the rule. This descriptive comment typically corresponds to the Process Design Manual rule name or rule descriptor, for example, GRMx.S.2 : Mx minimum.

The comparison result descriptions are text strings that describe each result being compared. The default rule-map file uses rule descriptions, if they are available, or creates default text descriptions. The tool uses these descriptions in the output report.

Example 4-1 shows the format of a rule map file with three rule groups.

Example 4-1 Rule-Map File Format

```
RuleGroup, BaselineRule, Baseline(L;D), ComparatorRule, Comparator(L;D), Description
     1   ,         F    ,         0;0   ,    F          ,            0;0   ,    Rule F
     2   ,         F.1  ,         1;0   ,    F_1        ,            1;0   ,    Rule F.1
     3   ,         B    ,         2;0   ,    RCT_genC_B ,            2;0   ,    Rule B
```

Note:
In a real rule-map file, the *layer*;*datatype* assignments might not be this well ordered.

The first non-empty line in the file is the header line. Newlines are significant only at the end of a record, and multiple contiguous newlines are treated as one newline. Other white space is ignored unless quoted. Commas can also be quoted, in which case they are not counted as a field separator.

The layer and datatype values from the baseline and comparator results are required. The lack of a value designates a NULL entry. However, an empty string ("") is not counted as a NULL value.

By default, the DCV Results Compare tool creates rule groups with 1:1 mappings based on matching layers and datatypes in the baseline and comparator data. When rule names do not match, or a rule in one file is not in the other file, the tool automatically generates a dummy rule name of the form RCT_genB_*rule-name* or RCT_genC_*rule-name*, where B indicates baseline data, C indicates comparator data, and *rule-name* is the generated rule name.

Note:
A rule identifier that appears in more than one rule group causes an error.

You can create *M*:*N* rule mappings by modifying the 1:1 mappings that the tool generates. Make sure you use the same rule group for all of the rules that are part of a particular *M*:*N* mapping.

In Example 4-2, rule groups 1 and 2 are 1:1 maps, group 3 is a 1:3 map, and group 4 is a 2:4 map:

Example 4-2 Rule Mappings Organized by Rule Groups

```
RuleGroup, BaselineRule, Baseline(L;D), ComparatorRule, Comparator(L;D),   Description
        1,       M1.S.2,         100;0,          M1_S_2,        15;0,  "M1 minimum space"
        2,       Mx.S.1,         101;0,          M1_S_1,       101;0,  "M1 minimum width"
        3,       Bx.R.3,         102;0,          B1_R_3,         1;0,     "B1 touching C"
        3,             ,              ,          B2_R_3,         1;1,     "B2 touching C"
        3,             ,              ,          B3_R_3,         1;2,     "B3 touching C"
        4,      GRD.R.1,         103;0,        GRD_R_1a,       200;0,      "Grid check 1"
        4,             ,              ,        GRD_R_1b,       201;0,      "Grid check 1"
        4,      GRD.R.2,         103;1,        GRD_R_2a,       202;0,      "Grid check 2"
        4,             ,              ,        GRD_R_2b,       202;0,      "Grid check 2"
```

Rule correspondence is controlled through the rule group identifier. In Example 4-3, rule groups 3 and 4 contain a rule name mismatch and rule groups 5 through 7 contain a 1:*N* rule mapping, which in this example is a single baseline rule matched by two rules in the comparator data.

Example 4-3 Rule Correspondence

```
RuleGroup, BaselineRule, Baseline(L;D), ComparatorRule, Comparator(L;D), Description
      1   ,          F   ,          0;0   ,              F ,      0;0   ,         "Rule F"
      2   ,        F.1   ,          1;0   ,            F_1 ,      1;0   ,         "Rule F.1"
      3   ,          B   ,          2;0   ,    RCT_genC_B ,      2;0   ,         "Rule B"
      4   , RCT_genB_BB ,          3;0   ,             BB ,      3;0   ,         "Rule BB"
      5   ,           Fx ,          4;0   ,   RCT_genC_Fx ,      4;0   ,         "Rule Fx"
      6   , RCT_genB_x1 ,          5;0   ,             x1 ,      5;0   ,         "Rule x1"
      7   , RCT_genB_x2 ,          6;0   ,             x2 ,      6;0   ,         "Rule x2"
```

Example 4-4 shows a customized version of the same rule-map file.

Example 4-4 Updated or Edited Rule-Map File

```
RuleGroup, BaselineRule, Baseline(L;D), ComparatorRule, Comparator(L;D), Description
      1   ,      F     ,        0;0   ,         F     ,          0;0   ,     "Rule F"
      2   ,      F.1   ,        1;0   ,         F_1   ,          1;0   ,     "Rule F.1"
      3   ,      B     ,        2;0   ,         BR    ,          3;0   ,     "Rule B"
      4   ,      FX    ,        4;0   ,         FX1   ,          5;0   ,     "Rule Fx1"
```

```
 4  ,            ,             ,         FX2   ,         6;0  ,      "Rule Fx2"
```

When you modify a rule-map file, ensure that

- Every line in the file contains six comma-separated fields, specifies a rule group ID, and has at least one baseline rule identifier or comparator rule identifier.
- Every rule identifier specifies a corresponding *layer*;*datatype* assignment.

  For example, if you specify a baseline rule identifier, you must also specify a *baseline-layer*;*datatype* assignment.
- Every unique rule group identifier has at least one baseline rule identifier and at least one comparator rule identifier.

Note:
Although the rule descriptions in the last field of each line are optional, you should include rule descriptions because the tool needs them to generate meaningful report information.

Example 4-5 shows the behavior of the `-missing_rules` command-line option.

Example 4-5 --missing_rules Command-Line Option

```
  ------------------
  COMPARISON SUMMARY
  ------------------

Rule       Baseline        Comparator   Result     Total      Total     Missed     False
Group      Rule Name        Rule Name            Baseline Comparator    Errors    Errors
    1         RULE_1   RCT_gen_RULE_1     FAIL        12          0        10         0
    2         RULE_2           RULE_2     PASS         1          1         0         0
  ----------------------
  MISSING BASELINE RULES
  ----------------------

        NONE
  ------------------------
  MISSING COMPARATOR RULES
  ------------------------

        RULE_1
```

Note:
By default, rules with zero violations do not appear in the comparison summary, but are still reported in the missing baseline or comparator rules sections if the “zero violation rule” does not appear in one of the inputs.

Comparison Results File

The DCV Results Compare tool produces a comparison report that describes how the comparator results correlate with the baseline results. This report contains a report header, a comparison summary, and a detailed comparison results section.

- The report header contains information about the tool release version, the total number of errors (from the baseline and comparator input), and the matched errors and unmatched errors (discrepancies) per rule.
- The comparison summary section summarizes each rule, indicating whether the rule has passed the comparison criteria or failed due to discrepancies.
- The detailed comparison results section gives detailed information about each rule. The section includes rule comments, rule identifiers, and any missed or false errors (discrepancies).

The report file name takes the form *top_cell*.RCT.report, where *top_cell* is the name of the top cell in the design.

For more information, see the following sections:

- Report Header
- Comparison Summary
- Detailed Comparison Results

Report Header

The report header contains the following information:

- Banner Information, which contains the tool release version
- Tool input information such as the baseline, comparator, and layout files and the tool called as information

Comparison Summary

The comparison summary section summarizes each rule, indicating whether the rule has passed the comparison criteria or failed due to discrepancies. The summary includes

- The rule group numbers, baseline and comparator rule identifiers, results (PASS or FAIL), total baseline errors, and total comparator errors
- The number of discrepancies in the comparator results that are not in the baseline results (false errors).

- The number of discrepancies in the baseline results that are not in the comparator results (missed errors).

The results in this section are organized in a decreasing order of priority:

- Rules with the largest number of missed errors and no false errors
- Rules with the largest number of false errors and no missed errors
- Rules with the greatest difference between missed and false errors
- Rules with no discrepancies (passing results)

Two or more rules that have equal priorities are ordered based on their rule-group IDs.

Example 4-6 shows an example of a comparison report summary. The summary results are sorted based on severity. The Missed Errors column shows the number of error results in the baseline data that are not in the comparator data. The False Errors column shows the number of error results in the comparator data that are not in the baseline data.

Example 4-6 Comparison Report Summary Example

```
          ------------------
          COMPARISON SUMMARY
          ------------------

Rule           Baseline     Comparator Result    Total      Total    Missed     False
Group         Rule Name      Rule Name         Baseline Comparator   Errors    Errors

   3             RULE_2         RULE_2   FAIL      2739       3528      850         0
  14             RULE_4         RULE_4   FAIL       851        460      209         0
  48             RULE_F         RULE_F   FAIL       228         96      120         0
   9            RULE_A1        RULE_A1   FAIL         3          2       50         0
  18            RULE_B1        RULE_B1   FAIL         9          9       24         0
  32             RULE_C         RULE_C   FAIL        11          1        5         0
  26            RULE_6b        RULE_6b   FAIL     12467    1589096        0    125670
   5             RULE_8         RULE_8   FAIL      2735     633190        0     96500
  16             RULE_H         RULE_H   FAIL       417      64417        0      3015
  17            RULE_SS        RULE_SS   FAIL       328       1314       39       589
  21            RULE_SX        RULE_SX   FAIL        16         16       12        64
  22            RULE_S2        RULE_S2   FAIL       370        371       30         1
  20            RULE_Se        RULE_Se   FAIL     18497        481      108       124
  23           RULE_Se3       RULE_Se3   PASS       299        299        0         0
```

In this example,

- The first six rule groups in the example have errors in the baseline data but none in the comparator data. The rules are sorted by number of discrepancies.
- The next three rule groups have errors in the comparator data but not in the baseline data. The rules are sorted by number of discrepancies.
- The next four rule groups have discrepancies in both the baseline and comparator data. The rules are sorted by largest delta to smallest delta.

- For the last rule group, the comparison matched. These results are sorted by the number of errors in the baseline data (Total Baseline).

Detailed Comparison Results

The detailed comparison results section gives detailed information about each rule, including rule comments, rule identifiers, and any missed or false errors. The results are similar to the presentation of errors in a LAYOUT_ERRORS file; the main difference is the details provided with the discrepancies.

Note:

The output report format might change depending on the command-line options that you specify.

The report displays basic rule group information and the results for each missed and false error for each rule group ID in ascending order. Example 4-7 shows the detailed results for a rule group with both missed and false errors.

Example 4-7 Comparison Report Detailed Results Section

```
        ---------------------------
        DETAILED COMPARISON RESULTS
        ---------------------------

Rule Group: 1
Baseline Rule Names: Rule_ABC
Comparator Rule Names: RCT_Rule_ABC
Description: rule_comment_or_description
Compare Result: FAIL
-------------------------------------------------------------------------

Missed errors: 8
-----------------------------------------------------------
    RCT (lower left x, y) (upper right x, y)
-----------------------------------------------------------
    (683.8800, 1864.2140) (683.9600, 1864.9060)
    (688.6800, 1864.2140) (688.7600, 1864.9060)
    (683.8800, 1858.4540) (683.9600, 1860.4800)
    (679.0800, 1858.9200) (679.1600, 1860.4800)
    (678.7600, 1857.1200) (678.8400, 1858.6800)
    (664.3600, 1864.2140) (664.4400, 1864.9060)
    (663.4000, 1858.4540) (663.4800, 1860.4800)
    (661.1600, 1858.4540) (661.2400, 1860.4800)

False errors: 6
-----------------------------------------------------------
    RCT (lower left x, y) (upper right x, y)
-----------------------------------------------------------
    (683.8800, 1864.2140) (683.9600, 1864.9060)
    (688.6800, 1864.2140) (688.7600, 1864.9060)
    (683.8800, 1858.4540) (683.9600, 1860.4800)
    (679.0800, 1858.9200) (679.1600, 1860.4800)
    (678.7600, 1857.1200) (678.8400, 1858.6800)
    (664.3600, 1864.2140) (664.4400, 1864.9060)
```

If you specify a waiver database, the report contains additional sections for waived comparison discrepancies. Example 4-8 shows an example of waived comparison discrepancies.

Example 4-8 Comparison Report Detailed Results for Waived Discrepancies

```
        --------------------
        WAIVED DISCREPANCIES
        --------------------

Rule Group: 21
Baseline Rule Names: Rule_BCD
Comparator Rule Names: RCT_Rule_BCD
Description: rule_comment_or_description
Compare Result: WAIVED
-------------------------------------------------------------------------

Missed errors waived: 2
-----------------------------------------------------------
    RCT (lower left x, y) (upper right x, y)
-----------------------------------------------------------
    (588.2150, 451.7400) (588.2200, 451.7450)
    (588.2100, 451.7350) (588.2150, 451.7400)

False errors waived: 0
```

LVS Results Comparison

Running the Tool

LVS results consists of two components: the extraction stage results and the compare stage results. The DCV Results Compare Tool compares them separately.

The syntax and input for these stages are different. See the following sections in this chapter for details about how to run the tool. The extraction stage results comparison is similar to the DRC flow, but provides a more detailed comparison of the text and device extraction errors. Unlike DRC rules comparison, the LVS extract stage compares more attributes than just coordinates.

The compare stage results comparison provides an overview of the differences of two LVS runs. You can see the differences in LVS results (equivalence type, compare options, error type, warning type, and statistics) from the output, which includes a summary for all equivalence points and a detailed report for each equivalence point.

Extraction Stage Results Comparison

The LVS extraction stage comparison results are similar to the DRC comparison results, but it has more detailed support for text and device extraction errors.

The LVS extraction stage results comparison command-line syntax is

```
dcv_rct
    [options]
    overlap | exact | fuzzy_exact
    baseline_data
    comparator_data
    layout_data
```

For example,

```
dcv_rct exact test1.LAYOUT_ERRORS test2.LAYOUT_ERRORS test.gds
```

The syntax and usage is the same as the DRC Results Comparison. See "Running the Tool" on page 4-7. For text and device extraction errors, only `exact` is supported regardless of the setting in the command line. However, the user-defined setting is applied to the other DRC rules.

Note:
Only IC Validator versus IC Validator comparison is supported.

The DCV Results Compare tool performs a runset command-based error-versus-error comparison of the error data and creates a comparison report for text and device extraction errors. The tool generates a report file, top_cell.RCT.report, where top_cell is the name of the top cell in the design.

Compare Stage Results Comparison

The DCV Results Compare tool provides a well-constructed output report for users to quickly and easily find the difference in LVS compare stage results.

The LVS compare stage results comparison syntax is

```
dcv_rct -lvs baseline run directory comparator run directory
```

Use the run_details directory of the original IC Validator run to execute the compare stage comparison. Using this syntax, you can compare the input _lvs.log file and compare directory that are generated by the IC Validator tool. The input directory must have the following structure:

```
input_directory/
      layout_equiv_cell/
             sum.block.block
      layout_equiv_cell/
             sum.block.block
```

The RCT_LVS_result output directory, created by the DCV Results Compare tool, contains all of the output reports for compare stage results.

Comparison Results File

The DCV Results Compare tool produces several comparison reports for LVS Comparison that describe how the comparator results correlate with the baseline results.

For extraction stage results, the report contains a report header, a comparison summary, and a detailed comparison results section.

- The report header contains information about the tool release version, the total number of errors (from the baseline and comparator input), and the matched errors and unmatched errors (discrepancies) per rule.
- The comparison summary section summarizes each rule, indicating whether the rule has passed the comparison criteria or failed due to discrepancies.
- The detailed comparison results section gives detailed information about each rule. The section includes, rule identifiers, and any missed or false errors (discrepancies).

The report file name is *top_cell*.RCT.report, where top_cell is the name of the top cell in the design.

For the compare stage results, the output is in a directory created by the DCV Results Compare tool, with the following structure:

```
RCT_LVS_result/
    lvs_RCT.report
    equivs/
           block.block.report
           block.block.report
           block.block.report
              …
```

For more information, see

- Report Header
- Extraction Stage Comparison Report
- Compare Stage Comparison Report

Report Header

The report header contains the following information:

- Banner Information, which contains the tool release version

- Tool input information such as the baseline, comparator, and layout files and the tool called as information

Extraction Stage Comparison Report

The DCV Results Compare tool report has two sections: the comparison summary and the detailed comparison summary results.

There are seven columns, five of which are the same as the DRC results report. Two new columns, Command and Error type, contains IC Validator command name and error type in the LAYOUT_ERRORS file or error database (PYDB).

Note:
The header will not be generated if no corresponding rules or commands are found.

Runsets can contain multiple error producing text commands (for example, `text_net()`) and each of those text functions can have multiple types of error results (for example, short, opens, and so on).

To properly distinguish these results, a number ID is added to the end of the command name, as shown in Figure 4-1. The ID number is based on the order of the commands in the runset.

If a given text command produces multiple errors of the same type (for example, `text_open_merge`), a number ID is added at the end of subsequent error types, as shown in Figure 4-1.

Figure 4-1 Comparison Summary Results Number ID

```
     ------------------
     COMPARISON SUMMARY
     ------------------

          Baseline                  Comparator Result      Total      Total     Missed      False
         Rule Name                   Rule Name          Baseline Comparator     Errors     Errors

layout_grid_errors          layout_grid_errors    PASS        14         14          0          0

           Command                       Error
                                          Type

        text_net-1                  text_short    FAIL       321        321          1          1
        text_net-1             text_open_merge    PASS         2          2          0          0
        text_net-1           text_open_merge-1    PASS         3          3          0          0
        text_net-1           text_open_merge-2    PASS         3          3          0          0
        text_net-2            text_open_rename    PASS         6          6          0          0
```

For these error producing text commands, the Detailed Summary Results contents are slightly modified from typical DRC results comparison. An example of this is shown in Figure 4-2. The rule group identifier is removed and a “Compare Result” is included to indicate if the result is missing from the Comparator or Baseline.

Figure 4-2 Detailed Summary Results

```
-----------------------------------------------------------------------------
Command: text_net-1
Error Type: text_short
Compare Result: Missing in comparator
-----------------------------------------------------------------------------
EPEnMRAM_cheetah  11  *  LM_TNOR_ENB  143  0  (-246.658000,1278.254000)  met[mlyr_name_list[c]]  LAYER
                            TNOR_ENB  142  0  (-246.658000,1831.634000)  met[mlyr_name_list[c]]  LAYER
```

Compare Stage Comparison Report

The LVS compare stage comparison output is in a directory with the following structure:

```
RCT_LVS_result/
    lvs_RCT.report
    equivs/
           block.block.report
           block.block.report
           block.block.report
              …
```

The lvs_RCT.report file is higher level summary of the Compare Stage results comparison (see Figure 4-3 for an illustration). The report contains two sections. The first section is a comparison of the runset level, for example, global, compare options settings. The second section contains an overview of the comparison for each sum.*block*.*block* file.

Figure 4-3 LVS Compare Summary Report

```
-----------------------------------------------------
                    COMPARE OPTIONS
-----------------------------------------------------

Options                        Baseline Settings                  Comparator Settings
-------                        -----------------                  -------------------
schematic global_nets           {}                                  {EXAMPLE}
power nets
   schematic                    {}                                  {EXAMPLE}

-----------------------------------------------------
             LVS RESULT COMPARE SUMMARY
-----------------------------------------------------

Compare     Equiv       Compare     Error       Warning     Netlist Stats  Netlist Stats  Equivs

Result      Type        Options     Messages    Messages    -Schematic     -Layout        schematic = layout

--------    --------    --------    --------    --------    -------------  -------------  ---------------------

OK          OK          UNMATCHED   UNMATCHED   OK          UNMATCHED      OK             sub = sub

OK          OK          UNMATCHED   OK          OK          UNMATCHED      UNMATCHED      top = top
```

The equivs directory contains individual *block*.*block*.report files, which are the detailed compare results for each sum.*block*.*block* file. See Figure 4-4 for an example of a *block*.*block*.report file.

Each *block*.*block*.report file is broken up into the following sections: EQUIV POINT, COMPARE RESULT, EQUIV TYPE, ERROR MESSAGES, WARNING MESSAGES, COMPARE OPTIONS, NETLIST STATISTICS - LAYOUT, and NETLIST STATISTICS -

SCHEMATIC. These sections correspond to the blocks of information compared within each sum.block.block file.

If all results for a section match, a “MATCHED” result will be shown, except for the EQUIV POINT, ERROR MESSAGES, and WARNING MESSAGES sections. For these, all of the information will be presented, whether they match or not. This is also illustrated in Figure 4-4.

Figure 4-4 Detailed Summary Results

```
-----------------------------------------------------
                     EQUIV POINT
-----------------------------------------------------

schematic = layout
------------------
sub = sub

-----------------------------------------------------
                     COMPARE RESULT
-----------------------------------------------------

MATCHED

-----------------------------------------------------
                      EQUIV TYPE
-----------------------------------------------------

MATCHED


-----------------------------------------------------
                     ERROR MESSAGES
-----------------------------------------------------

Baseline Errors                         Count          Comparator Errors                       Count
---------------                         -----          ----------------                        -----
one-connection non-port layout net      1               one-connection non-port layout net     1
one-connection non-port schematic ne@   1
```

EQUIV POINT

The EQUIV POINT section of the report displays the cell name in the schematic design and layout, as shown in Figure 4-5.

Figure 4-5 EQUIV POINT Section

```
-----------------------------------------------------
                     EQUIV POINT
-----------------------------------------------------

schematic = layout
------------------
sub = sub
```

ERROR MESSAGES

The ERROR MESSAGES and WARNING MESSAGES sections list all of the errors and warnings whether or not they are different. You must determine if the errors or warnings are the same by reviewing the original LVS report. For example, in Figure 4-6, the first error message is the same for both LVS runs, but the detail of this error can be different.

Figure 4-6 ERROR MESSAGES Section

```
-----------------------------------------------------
                     ERROR MESSAGES
-----------------------------------------------------

Baseline Errors                         Count         Comparator Errors                       Count
---------------                         -----         ----------------                        -----
one-connection non-port layout net      1              one-connection non-port layout net     1
one-connection non-port schematic ne@   1
```

COMPARE OPTIONS

The COMPARE OPTIONS section is similar to section in the summary report, but it compares the LVS compare options for this equivalence instead of the runset setting, as shown in Figure 4-7.

Figure 4-7 COMPARE OPTIONS Section

```
-----------------------------------------------------
                    COMPARE OPTIONS
-----------------------------------------------------

Options                      Baseline Settings                  Comparator Settings
-------                      -----------------                  -------------------
print_messages
   pre_merge_stats            false                               true
```

NETLIST STATISTICS

The NETLIST STATISTICS section lists the differences of entries in the statistics report; the entries without differences are not shown. Schematic and layout statistic differences are reported in two sections, as shown in Figure 4-8.

Figure 4-8 NETLIST STATISTICS- SCHEMATIC

```
-----------------------------------------------------
            NETLIST STATISTICS - SCHEMATIC
-----------------------------------------------------

Initial        PushDown       Filter         Parallel       Path/Ser       RecogGate      Final          Device type

(base|comp)    (base|comp)    (base|comp)    (base|comp)    (base|comp)    (base|comp)    (base|comp)
-----------    -----------    -----------    -----------    -----------    -----------    -----------    -----------

0|2                                                                                       0|2            PMOS[N]

=====================================================================================================================

Initial        PushDown       Dangle         0 Connect      Path/Ser       RecogGate      Shorted        Total nets

(base|comp)    (base|comp)    (base|comp)    (base|comp)    (base|comp)    (base|comp)    (base|comp)    (base|comp)
-----------    -----------    -----------    -----------    -----------    -----------    -----------    -----------

                                                                           0|5                           5|4
```

Waiver Conversion Flow

The DCV Results Comparison Tool can be used to convert third-party waiver GDSII files to an equivalent IC Validator error classification database (cPYDB). The tool performs a rule-based correlation of the third-party waiver GDS shapes against a corresponding IC Validator PYDB error database. All waiver shapes, and associated waiver comments that correlate to a matching IC Validator error shape are written to the cPYDB.

Running the Tool

The waiver conversion flow command-line syntax is

```
dcv_rct
    [options]
    overlap | exact | fuzzy_exact
    IC Validator PYDB
    3rd party Waiver GDSII
    layout_data

    -m <Waiver Description File>
```

To convert the waivers from the file named Waiver.gds, the corresponding IC Validator PYDB database named PYDB_TOP, the original layout data in a file named TOP_input.gds, and the waiver description file named waiver_input.txt, type the following at the command line:

```
% dcv_rct exact Waiver.gds ./PYDB_TOP TOP_input.gds -m waiver_input.txt
```

Input Database Formats

For the waiver conversion flow, the supported database formats are limited to the following:

- IC Validator PYDB database
- Third-party waiver GDSII file

The tool auto-detects the formats so the databases can be specified in any order.

Waiver Description File

For the waiver conversion flow, you must specify a waiver description file. This file provides information about the mapping of the layer;datatype assignments in the third-party waiver GDSII data. The file must contain the following:

- Layer;Datatype assignment for the waiver shapes. Specifies the assignment of the waiver polygon marker layers.
- Layer;Datatype assignment for the waiver comments.Specifies the assignment of the waiver comment text. These comments are typically used to describe the justification for granting a waiver.
- Layer;Datatype assignment for the user name. Specifies the assignment for the name of the person who approved of the waiver.
- Layer;Datatype assignment for the date layer. Specifies the assignment for the date when the waiver was approved.

The format for specifying information is illustrated in the following example:

Example 4-9 waiver_input.txt

```
WAIVER SHAPES:  (164;99)
WAIVER COMMENTS:  (164;2)
USER NAME  :  (164;5)
DATE            :  (164;3)
```

Note:

The terminology and specification of information is based on the standard content supported by the third-party waiver GDSII database for classification and documentation of approved waivers.)

Output

The DCV Results Compare tool waiver conversion flow produces the following output:

- IC Validator Error Classification Database (cPYDB)
- Correlation Report File

IC Validator Error Classification Database

The error classification database contains all the violations from the IC Validator PYDB that successfully correlated with the corresponding third-party waiver data. In addition to the correlated shapes data, all waiver comments, including user names, and dates are included in the output cPYDB. You can then use this auto-generated error classification database with follow-on IC Validator runs to apply the same waivers that were applied in the third-party DRC run.

Correlation Report File

The DCV Results Compare tool produces a report that specifies whether the conversion is successful. The report contains the header, correlation summary, and a detailed results section. See the Report Header section for more information.

Waiver Correlation Summary

The correlation summary section summarizes each rule, indicating whether the rule from the IC Validator PYDB has completely correlated with the third-party waiver or not. See Figure 4-9.

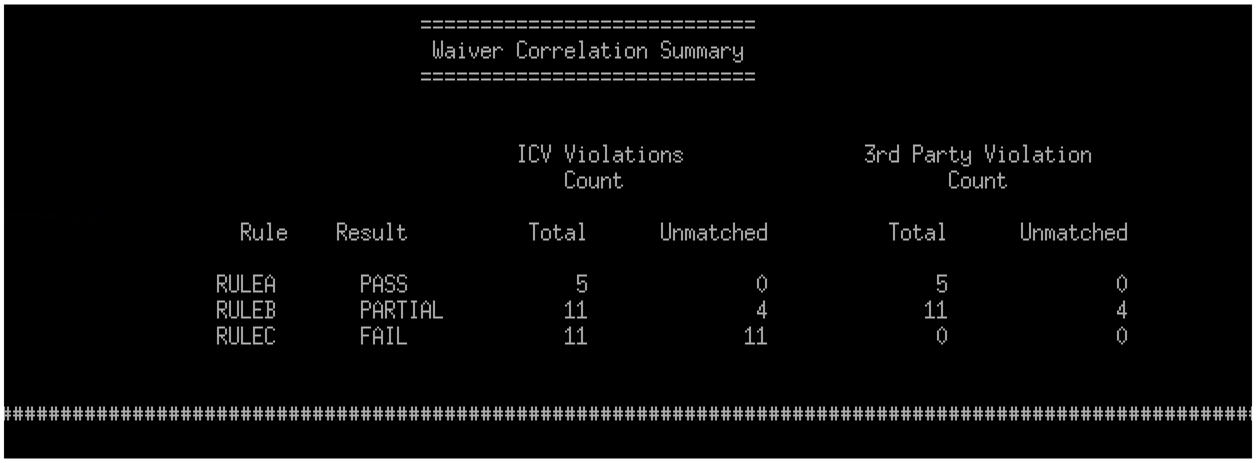
The summary includes the following:

- Rule name, correlation result for that rule, Total violation counts for IC Validator and third-party inputs, and Total Unmatched violation counts for IC Validator and third-party inputs.

There are three possible correlation results:

- PASS. All of the IC Validator violations successfully correlated with all third-party waiver data for a given rule.
- PARTIAL. Some of the IC Validator violations successfully correlated with third-party waiver data but there are also some uncorrelated results. Results that successfully correlated *will* be written to the output cPYDB error classification database.
- FAIL. There was no successful correlation between IC Validator violations and third-party waiver data.

Figure 4-9 Waiver Correlation Summary



```
                            ============================
                             Waiver Correlation Summary
                            ============================


                                    ICV Violations              3rd Party Violation
                                        Count                          Count

                 Rule     Result         Total       Unmatched       Total       Unmatched

               RULEA       PASS             5               0           5               0
               RULEB       PARTIAL         11               4          11               4
               RULEC       FAIL            11              11           0               0


##########################################################################################
```

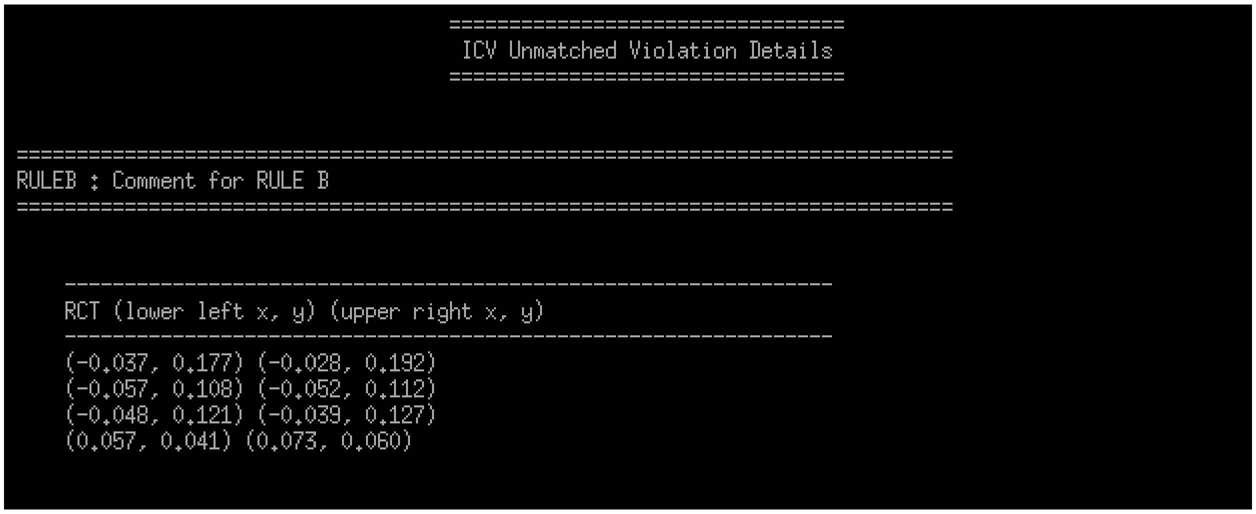
Detailed Results

The detailed results section provides detailed information about each unmatched rule, including rule comments and original cell(s) in which the violation was reported, wherever applicable.

This section is separated into two components: one containing the unmatched violations from the IC Validator PYDB input and the other containing information from third-party waiver input.

The results are similar to the presentation of errors in a LAYOUT_ERRORS file; The primary difference is shown in Figure 4-10 and Figure 4-11.

Figure 4-10 Unmatched Violation Details

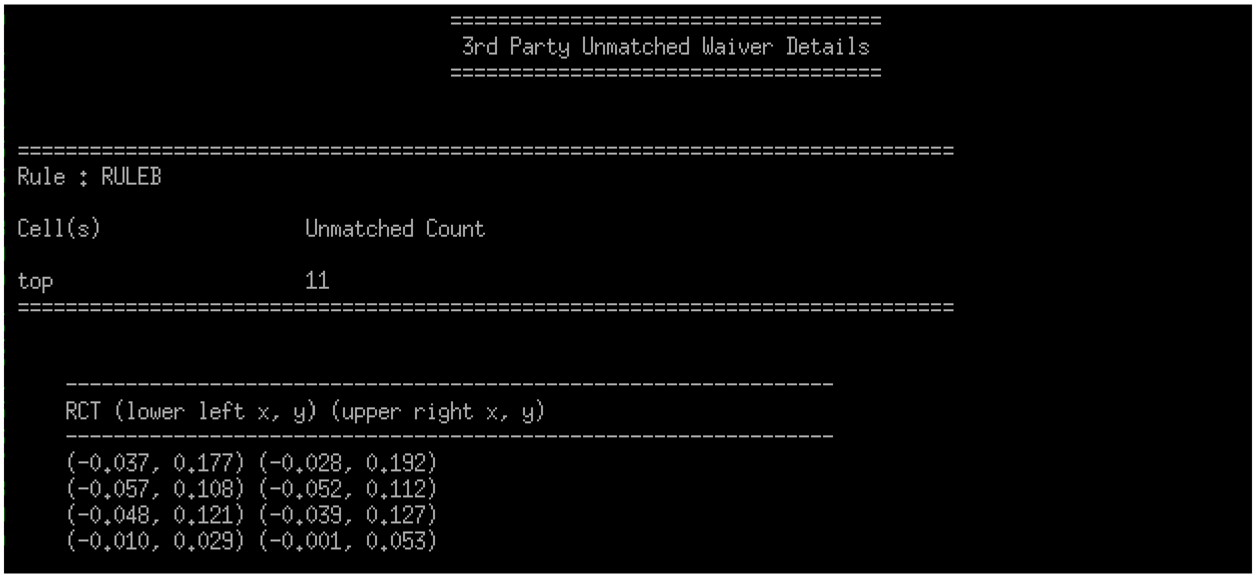


```
                                  ==================================
                                   ICV Unmatched Violation Details
                                  ==================================


================================================================================
RULEB : Comment for RULE B
================================================================================


    ------------------------------------------------------------------
    RCT (lower left x, y) (upper right x, y)
    ------------------------------------------------------------------
    (-0.037, 0.177) (-0.028, 0.192)
    (-0.057, 0.108) (-0.052, 0.112)
    (-0.048, 0.121) (-0.039, 0.127)
    (0.057, 0.041) (0.073, 0.060)
```

Figure 4-11 Third-Party Unmatched Waiver Details



```
                                    ====================================
                                     3rd Party Unmatched Waiver Details
                                    ====================================


==============================================================================
Rule : RULEB

Cell(s)                 Unmatched Count

top                     11
==============================================================================


    ----------------------------------------------------------------
    RCT (lower left x, y) (upper right x, y)
    ----------------------------------------------------------------
    (-0.037, 0.177) (-0.028, 0.192)
    (-0.057, 0.108) (-0.052, 0.112)
    (-0.048, 0.121) (-0.039, 0.127)
    (-0.010, 0.029) (-0.001, 0.053)
```

5

DCV Test Case Compiler Tool

This chapter explains how to run the DCV Test Case Compiler tool.

The IC Validator DCV Test Case Compiler tool generates non-functional layout database files for use in testing IC Validator runsets.

For more information, see the following sections:

- Overview
- Prerequisites
- Running the Tool

Overview

The DCV Test Case Compiler tool (`dcv_tcc`) can be used to create a variety of layouts for testing a new IC Validator runset for both functional and performance purposes. The DCV Test Case Compiler tool takes an abstract description via a configuration file and creates a layout database (GDSII or OASIS) to use in testing the IC Validator runset. These layouts are non-functional, but ideally realistic enough to be useful for testing various aspects of the IC Validator runset, such as DRC, LVS, FILL, and so on.

Prerequisites

The DCV Test Case Compiler tool (`dcv_tcc`) requires an IC WorkBench EV Plus license to run.

Running the Tool

Before running the DCV Test Case Compiler tool, make sure the `LM_LICENSE_FILE` and `ICV_HOME_DIR` environment variables are set. The `dcv_tcc` executable is located in the same bin directory as the `icv` executable. All output, that is, logs and new layout, are generated in the current working directory.

The DCV Test Case Compiler tool command-line syntax is

```
dcv_tcc [options]
```

or

```
dcv_tcc [config_file]
```

where

- *options* are described in Table 5-1 on page 5-3
- config_file is described on page 5-4

The recommended flow is to generate a configuration file using the `-g` command-line option, edit that file, and resubmit it to the tool to generate the final GDSII or OASIS file.

Note:
More hierarchical structures can be created by running the tool iteratively. For more information, see page 5-7.

For more information, see the following sections:

- Command-Line Options

- Environment Variables
- Configuration File
- Iterative Execution

Command-Line Options

Table 5-1 describes the command-line options.

Table 5-1 DCV Test Case Compiler Command-Line Options

Option	Description
`-g -genConfig`	Prints an example configuration file with comments, which can be edited and re-input into the tool.
`-V` `-version`	Prints the tool version.
`-h` `-help`	Displays the usage message and exits.

Environment Variables

You can control the appearance of the standard output and log files by setting the following DCV Test Case Compiler environment variables:

- `DCV_PROGRESS_SECONDS`

  Set this variable to change the frequency of Progress Line updates. The value must be an integer. The default is `60`.

- `DCV_TCC_ICWBEV_PATH`

  This is the directory containing the `icwbev` executable. If the `icwbev` executable is in your path before launching the run, the tool will use it, and this variable is not needed. If this is set, it will override the path in your regular environment. It is recommended that you use a comparable version to the version of IC Validator being used. An IC WorkBench EV license is required to run this tool.

- `DCV_TCC_WORKDIR`

  Set this variable to dictate where any intermediate files go for the run. If not set, the files will print to the current working directory.

Configuration File

The configuration file contains all of the specific information about how the DCV Test Case Compiler tool generates the final GDSII or OASIS file. Use the `-g` command-line option to generate an example configuration file, which can be edited and resubmitted to the tool.

The configuration file is setup in a *keyword=value* context. Lines beginning with a pound sign (#) are considered comment lines. Many of the keywords are binary in nature, in which case 0 is considered false and 1 is considered true. Keywords and descriptions are:

Table 5-1 describes the DCV Test Case Compiler configuration files.

Table 5-2 DCV Test Case Compiler Configuration Files

Keyword	**Description**
`tccMode` *`ENUM`*	Available `tccMode` enumerators: `cellRepeater`: Takes a list of cells and other directives and creates a new layout with the specified number of copies. Note: The keyword precedence is applied when forcibly merging cell names or making them unique: `depth` `addSuffix` `removePrefix` `mergeLeafCells` `retain` `rename`.
`inputLayout` *`gds/oasis file list`*	Specifies the input GDSII or OASIS comma-separated file list. Merges only those cells in the `repeatCells` list and takes the cell from the last file if there is a conflict. This keyword is required.
`repeatCells` *`cell-list`*	Specifies a comma-separated list of cells to repeat (A,B,C), and accepts Tcl-based regular expression examples: • .* for all cells • .*INV.* for anything with INV • .*[^.*INV.*].* for anything without INV Note: You can create uneven ratios of cells A,A,B, which places two instances of cell A for every instance of cell B. All cells are considered regular expressions. A warning message is emitted if the regular expression cannot be found in any `inputLayout`, if none are found the job will fail. This keyword is required.
`repeaterMode` *`ENUM`*	Specifies `count` or `size` mode. This keyword is required.

Table 5-2 DCV Test Case Compiler Configuration Files (Continued)

Keyword	Description
`count` *`INT`*	Specifies the number of instances placed in the output file when `repeaterMode=count`. This keyword is required if `repeaterMode=count`.
`xDim` *`REAL`*	Specifies the dimension in millimeters of the x-direction of space to fill when `repeaterMode=size`. This keyword is required if `repeaterMode=size`.
`yDim` *`REAL`*	Specifies the dimension in millimeters of the y-direction of space to fill when `repeaterMode=size`. This keyword is required if `repeaterMode=size`.
`rotate` *`Binary`*	Specifies whether the cell is rotated.
`mirror` *`Binary`*	Specifies whether the cell is mirrored (flipped).
`xOff` *`REAL`*	Specifies offset in the x-direction in DB (database unit), typically 1e-9. Positive numbers create buffer space and negative overlap.
`yOff` *`REAL`*	Specifies offset in the y-direction DB (database unit), typically 1e-9. Positive numbers create buffer space and negative overlap.
`depth` *`INT`*	Specifies depth level (from the top). To add a suffix or remove a prefix at the cell depth, `addSuffix` or `removePrefix` must be `>0`.
`addSuffix` *`Binary`*	Adds a unique suffix to cells, and goes down to the specified hierarchy depth.
`removePrefix` *`Binary`*	Removes prefixes from cell names to merge them, and goes down to the specified hierarchy depth.
`mergeLeafCells` *`Binary`*	Restores all leaf cells to their original names.
`retain` *`cell-list`*	Specifies a comma-separated list of cells to forcibly remove all prefixes and suffixes.
`rename` *`cell-list`*	Specifies a comma-separated list of cells to forcibly remove or add a suffix.
`prefix` *`string`*	Specifies the prefix to use (appended with #_).

Table 5-2 DCV Test Case Compiler Configuration Files (Continued)

Keyword	**Description**
`suffix` *`string`*	Specifies the suffix to use (appended with #).
`fillSpace` *`Binary`*	When specifying multiple cells, abuts as many small cells in the same orientation to fill the footprint of the largest specified cell, but might still have gaps depending on size ratios.
`cleanup` *`Binary`*	Cleans up unused cells.
`overwriteOriginal` *`Binary`*	Overwrites output file, if it exists (copies to original file; otherwise, any original files will be overwritten).
`outputTop` *`string`*	Specifies the output file name. If omitted, the output file name is *outputTop*.oasis.
`outputFile` *`string`*	Specifies the output file name. If omitted, the output file name is *outputTop*.oasis.
`terminateTimeMinutes` *`REAL`*	Terminates the `dcv_tcc` run after the designated minutes have expired if `>0`.
`terminateMemoryGB` *`REAL`*	Terminates the `dcv_tcc` run if the designated amount of memory in GB is exceeded (no limit if `<=0`).
`terminateMemoryFreeGB` *`REAL`*	Terminates the `dcv_tcc` run if the amount of free memory in GB on the machine drops below the specified amount (no limit if `<=0`).
`terminateMemoryPercent` *`REAL`*	Terminates the `dcv_tcc` run if the run exceeds the percentage of total memory on the machine from which it is running (no limit if `<=0`).
`terminateDirSizeGB` *`REAL`*	Terminates the `dcv_tcc` run if the directory size in GB changes by more than the specified amount (no limit if `<=0`). Note: The `terminate*` options are not required, but exist to monitor the job since it is potentially easy to set options along with input data that might exceed the available hardware limitations.

Iterative Execution

To create a more complex example with deeper hierarchy from simple cells, do the following:

1. Type: `dvc_tcc -g`

   Generates an example configuration file

2. Edit the configuration file

   Point to the input GDSII file and specify the cells to be replicated

   Change any other options as needed

   Specify values for outputTop and outputFile (use these names in subsequent runs, as this will be easier than using the auto-generated names)

3. `Type: dcv_tcc` *`edited_config_file`*

   Creates the new data

4. Create a new configuration file

   Repeat steps 1 and 2 or copy the file from step 3 and edit

   Include outputTop in the repeatCells list and outputFile in the GDSII/OASIS inputLayout list (you can include other files as well)

5. `Type: dcv_tcc` *`new_edited_config_file`*

   Creates a larger version of the data from step 3 with a deeper hierarchy

6. Repeat steps 4 and 5 as often as necessary depending on the overall target size and depth of the desired hierarchy in the final layout