Layout Verification in Batch Mode

1. Introduction

Verification of a layout design can be executed in GUI (Graphical User Interface) mode and batch mode in Silvaco's Custom IC CAD ools.

GUI mode displays the execution result of the command input from the keyboard and the mouse on the screen.

Batch mode is executed with specified option and file, and the result is output to the file.

We introduce the method of executing the following layout verification in the batch mode by using Expert 4.8.20.R or higher.

- DRC(Design Rule Check)
- Making the netlist
- LVS(Layout Versus Schematic)
- Parasitic Extraction

2. Execution of DRC Script (Execution of GuardianDRC)

Use the "guardiandrc –b" command to execute the DRC script in batch mode.

The parameters specifying the details of the DRC execution are specified at this point as follows:

```
>guardiandrc —b <parameters>
```

The GDSII file, technology file, DRC script file, top cell name, and DRC execution options are specified as parameters.

Alternatively, a configuration file containing parameters can be specified as follows:

```
>guardiandrc —b <parameter_file_name>
```

Refer to "2.4.3.2: Off-Line or Batch mode" of the "Guardian Layout Verification Users Manual" for details of each parameter.

Execution example 2-1:

```
>guardiandrc —b gds=design.gds
tcn=design.tcn dsf=design.dsf Top_
Cell=opamp Log=on
```

Execution example 2-2: The version and parallel mode are specified

```
>guardiandrc —V 4.8.20.R —b gds=design.
gds tcn=design.tcn dsf=design.dsf Top_
Cell=opamp Log=on Parallel_threads=2
```

Execution example 2-3: A parameter file is used

```
>guardiandrc —V 4.8.20.R —b drc_param.
txt  (See Figure 1)
```

An error message is displayed in the Windows command prompt or the Linux terminal when there is an error in the specified parameters after executing the DRC script.

Specify "Log=on" for parameters when you want to confirm the execution result of the DRC script.

<cellname>.log file is made in the execution directory after the DRC script is executed and the content can be confirmed.

Any detected DRC errors are output to the DRC error database (.edb file).

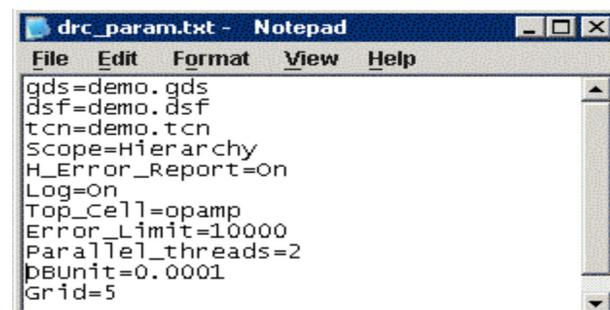The DRC errors are displayed in the layout after the DRC error database is loaded by Expert.

Figure1. Content of drc_param.txt.

Once the DRC errors are loaded, the designer can correct them while confirming the error.

3. LPE (Layout Parameter Extraction) Setting

The LPE setting sets an item necessary to make an LVS netlist and parasitic netlist.

The LPE setting is set from the Expert GUI.

Open the LPE setting dialog by selecting "Verification->Extraction->Setup" from the Expert menu.

Set the necessary items and the LPE setting file is created by clicking "Save…" . (See Figure 2).

4. Making the LVS Netlist
(Execution of Guardian LPE)

The "guardianlpe" command is used for making an LVS netlist in batch mode.

Execution of guardianlpe is:

```
>guardianlpe <parameters>
```

The ELD project file or GDSII file with technology file, the specific LPE setting file (.lpe or .epo file) and the LPE execution options are specified as parameters.

Refer to "3. LPE setting" for the method of making the LPE setting file.

Refer to "Expert Version 4.8.20" of "Expert Release Notes" for details of the LPE execution options.

Execution example 4-1: ELD project file is used

```
>guardianlpe —eld design.eld —epo de-
sign.lpe —lpe
```
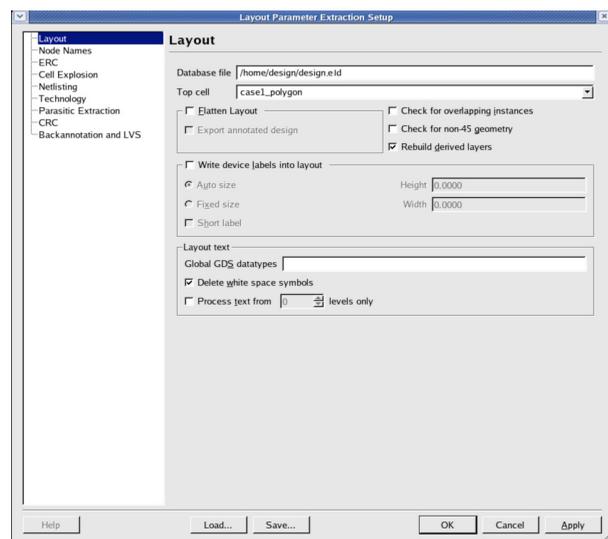

Figure2. LPE setting.

Execution example 4-2: GDSII file is used

```
>guardianlpe —eld design.gds —tcn de-
sign.tcn —epo design.lpe —lpe
```

Please note that the design.eld project file that exists in the execution directory is overwritten when the GDSII file is used.

Execution example 4-3: Version and top cell are specified

```
> guardianlpe —V 4.8.20R —eld design.eld
—epo design.lpe —laytop:opamp —lpe
```

When you want to confirm the log at the time when the netlist is made, specify "-o log_file_name" (The log_file_name is an absolute path) as parameters.

Execution example 4-4: Log file is specified

```
> guardianlpe —eld design.eld —epo de-
sign.lpe —laytop:opamp —lpe —o /home/
design/output.log
```

Because the log file is created in the specified place, the content can be confirmed.

The designer can confirm the <cellname>_NETLIST.sum file and the <cellname>_HIPEX.sum file is made where ever the netlistm file is made.

The netlist is made in the execution directory as the <cellname>_hier.spice file.

5. Execution of LVS
(Execution of GuardianLVS)

The "guardianlvs" command is used to execute the LVS in batch mode.

Execution of guardianlvs is:

```
>guardianlvs [—b|—c] <project_file_name>
```

—b shows the Verification Process dialog to see the progress of netlist comparison.

—c does not show the Verification Process dialog.

The project_file_name is a project file (.gpr file) including the LVS setting.

The project file is set from GuardianLVS using the GUI.

The project settings dialog is opened by selecting "Setup->Project Settings…" from the GuardianLVS menu. Set the necessary items and the project file is created by clicking the "Save" button. (See Figure 3).

Refer to "4.2.1: Starting LVS" of "Guardian Layout Verification User's Manual" for details.

Execution example 5-1: The Verification Process dialog is displayed

```
>guardianlvs —b design.gpr
```
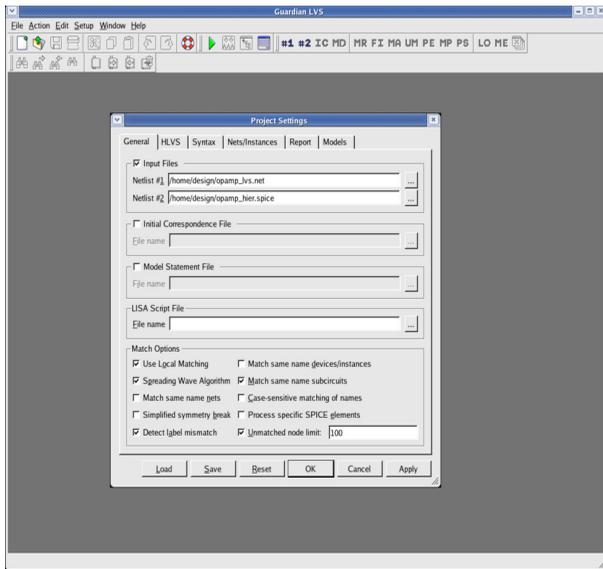
Figure 3. Project settings.

Execution example 5-2: The Verification Process dialog is not displayed

```
>guardianlvs —c design.gpr
```

Refer to the <cellname>_lvs.log file in the <cellname>_lvs#lvs directory made in the execution directory to confirm the execution result of LVS.

6. Execution of Parasitic Extraction (R,C,RC) (Execution of Hipex-R, Hipex-C, Hipex-RC)

It is necessary to perform the netlist extraction with Hipex-Net before the parasitic extraction is executed. It is also possible to execute the parasitic extraction and Hipex-Net at the same time.

When the layout and the rule file are changed, it is necessary to execute Hipex-Net again.

Execution of guardianlpe is:

```
>guardianlpe <parameters>
```

The ELD project file or GDSII file with technology file, the specific LPE setting file (.lpe or .epo file) and the LPE execution options are specified as parameters.

Refer to "Expert Version 4.8.20" of "Expert Release Notes" for details of the LPE execution options.

Execution example 6-1: Only the parasitic resistance extraction is executed from the ELD project file (Hipex-Net is executed beforehand):

```
>guardianlpe —eld design.eld —epo de-
sign.lpe —hipex_r
```

Execution example 6-2: A top cell is specified from the GDSII file, and only the parasitic capacitance extraction is executed (Hipex-Net is executed beforehand):

```
>guardianlpe —eld design.gds —tcn de-
sign.tcn —epo design.lpe —laytop:opamp
—hipex_c
```

Execution example 6-3: The version is specified from the ELD project file, and parasitic resistance and the parasitic capacitance extraction are executed:

```
>guardianlpe —V 4.8.20.R —eld design.
eld —epo design.lpe —laytop:opamp —lpe
—hipex_rc
```

Execution example 6-4: Hipex-Net, parasitic resistance and the parasitic capacitance extraction are executed from the GDSII file at the same time:

```
>guardianlpe —V 4.8.20.R —eld design.
gds —tcn design.tcn —epo design.lpe
—laytop:opamp —lpe  —hipex_rc
```

Execution example 6-5: Hipex-Net and all parasitic extractions are executed from the ELD project file at the same time:

```
>guardianlpe —V 4.8.20.R —eld design.
eld —epo design.lpe —laytop:opamp —lpe
—hipex_r —hipex_c —hipex_rc
```

Sometimes a GDSII or ELD file may contain two layers with the same GDSII and datatype number. If this is the case, a special setting in Expert needs to be activated in order to handle such situation. The setting is "Allow layers with the same GDSII numbers/datatypes".

The Expert configuration file (*.ecf) that reflects this special setting, needs to be provided in order to execute a parasitic extraction on a file that contains two layers with the same GDSII and datatype number. Note that the technology file also needs to be provided.

The following two lines are described in the configuration file and it executes a parasitic extraction as follows.

[Application]

AllowSameGDS=1

Execution example 6-6: Only the parasitic resistance extraction is executed from GDSII file with the configuration file:

```
>guardianlpe —V 4.8.20.R —eld design.gds
—tcn design.tcn —ecf design.ecf —epo
design.lpe —laytop:opamp —lpe  —hipex_r
```

Specify "—o log file name" (the log file name is an absolute path) for parameters to confirm the log of the parasitic extraction.

The log file is created in the specified path.

7. Procedure for making the netlist of backannotation

7-1: Execute "4. Making the LVS netlist", and make the netlist.

7-2: Execute "5. Execution of LVS", and confirm two netlists are EQUIVALENT.

7-3: Modification of the LPE setting file (.lpe or .epo file) (See Figure4)

When "4. Making of the LVS netlist" is executed from the ELD project file, the derived layer is constructed to recognize the device.

The construction of the derived layer does not need to execute again as long as the layout is not changed.

It changes to "Rebuild=0" in the LPE setting file

In order to treat any unnecessary ".MODEL" statement for simulation as a comment, it changes to "CommentModel =1".

The net name used in the schematic is reflected in the netlist of the backannotation.

The following items are specified

"Enable=1": enables backannotation.

"LVSProject=/home/design/opamp_lvs#lvs/default.gpr" :

It specifies the project file (default.gpr) made after LVS is executed.

"SchematicFile=/home/design/opamp_lvs.net" :

Specifies the schematic netlist used in the LVS.

"UseLVSProject=1":

Enables the use of the specified project file.

7-4: "4. Making the LVS netlist" is executed using the corrected LPE settings file.

7-5: The netlist for the backannotation is made by executing "6. Execution of Parasitic Extraction(R,C,RC)".

8. Conclusion

The layout verification can be executed from the specified GDSII file using batch mode.

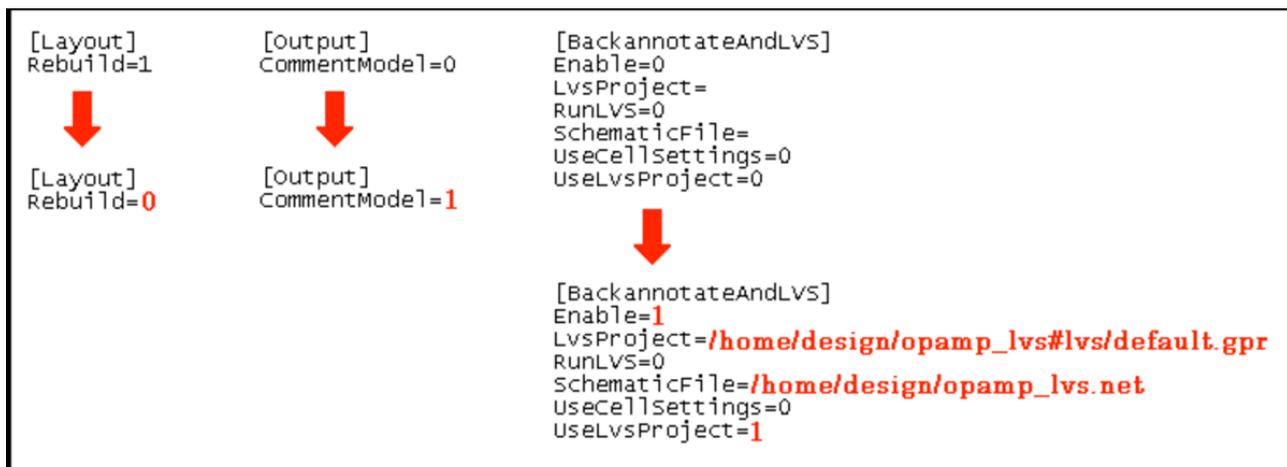After the layout verification is executed in batch mode, it releases the license when the process is completed allowing the license to be used efficiently.

Figure 4. Modification of opamp.lpe file.