SIEMENS EDA

How to Make Calibre PEX Recognize your Ground Layers

2023.3

Outline

- Objective
- Included Files
- Description
- Directions
- Conclusion

Objective

This Support Kit should help you understand how to setup Calibre PEX for multi-substrate handing using **PEX GROUND LAYER** SVRF statement such that:

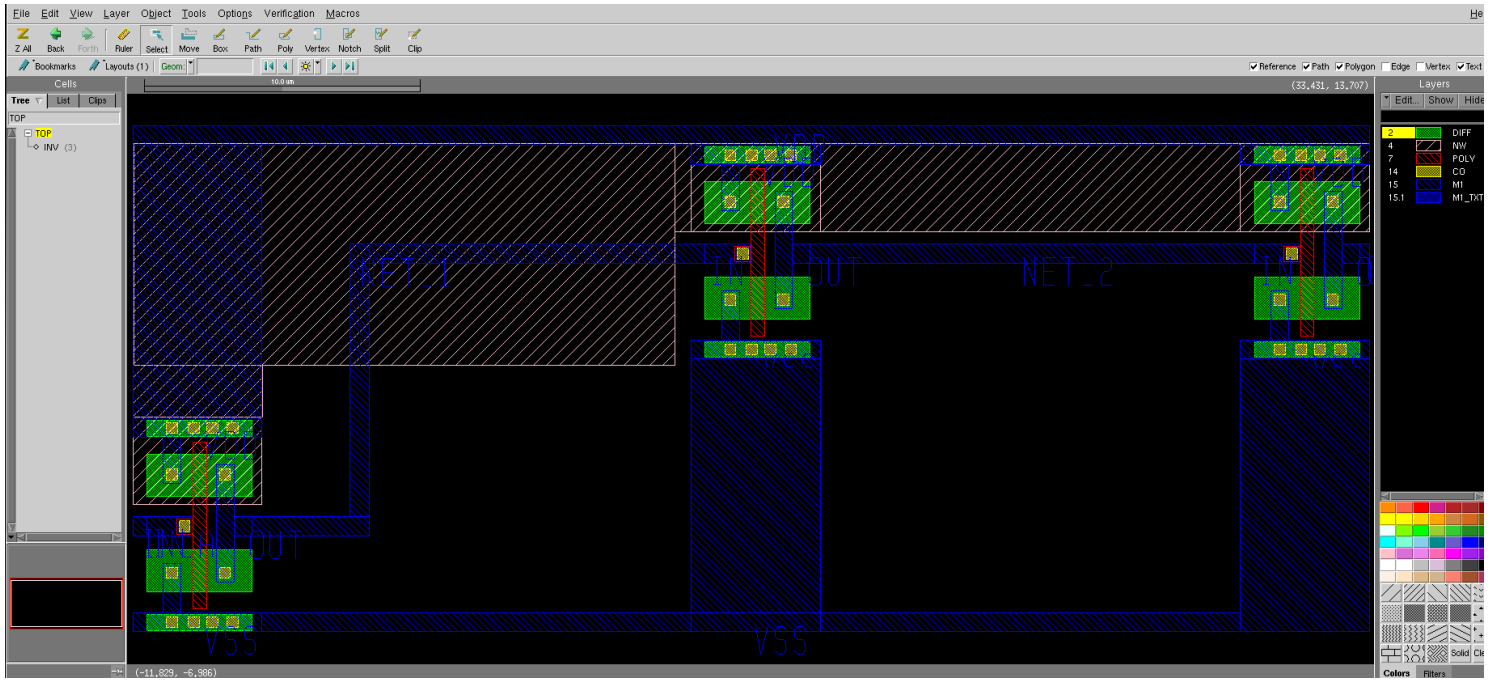
- Calibre PEX recognizes the ground layers in your design
- The intrinsic capacitance of routes are converted to couplings to underneath ground regions

Included Files

File	Description
layout.gds	Sample GDS file
layout.gds.layerprops	Layer properties file to annotate the layer names
runme	Script to run Calibre xRC
hcells.txt	hcell file
top-rules.xrc	top level rule deck
source.sp	Sample spice netlist
rules.lvs	LVS rule deck
rules.C	Parasitic capacitance rule deck
rules.R	Parasitic resistance rule deck
mv-results.csh	Script to move the results of each run into the designated directory
cleanme	Script to clean up the run directory

Description
>> Layout

View the sample layout file with the command: `calibredrv layout.gds`



Notes:
- Press 9 to view all the GDS hierarchy levels
- After examining the layout close Calibre DESIGNrev

Note the Following:
- NET_1 is using M1 as routing which is passing over NWELL and Substrate Regions
- NET_2 is also using M1 as routing which is passing over the Substrate region only
- NEWLL is connected to net VDD
- Substrate is connected to net VSS

Description

- By default, Calibre will extract and tie the intrinsic capacitance of nets to a virtual ground “0”. To specify the ground name in your design to be used instead, use **PEX NETLIST .. GROUND *ground_name***

- Though the aforementioned approach does include the loading effect of nets, with designs that contain multiple ground layers, this approach is not sufficient to include the effects of couplings to the correct underneath ground layer. Moreover, since this is based on a virtual ground net name, the intrinsic capacitances of nets that are physically connected to underneath grounds are not eliminated.

- In order to make Calibre PEX recognize the physical ground layers in your design and couple the intrinsics to the correct underneath ground, the following *SVRF* statement should be specified:
  PEX GROUND LAYER [STRAY | PRESERVE] ***layer_name*** [*layer_name*…]

- The layer names specified should contain the ground shapes and appear in a **CONNECT** statement. Moreover, When ground shapes overlap, the precedence is determined by the layer order defined within **PEX GROUND LAYER** statement

- The STRAY option is used to eliminate all STRAY intrinsic capacitances to the virtual ground, consequently, all the stray intrinsic capacitances will couple to the nets tied to the underneath ground regions

Description

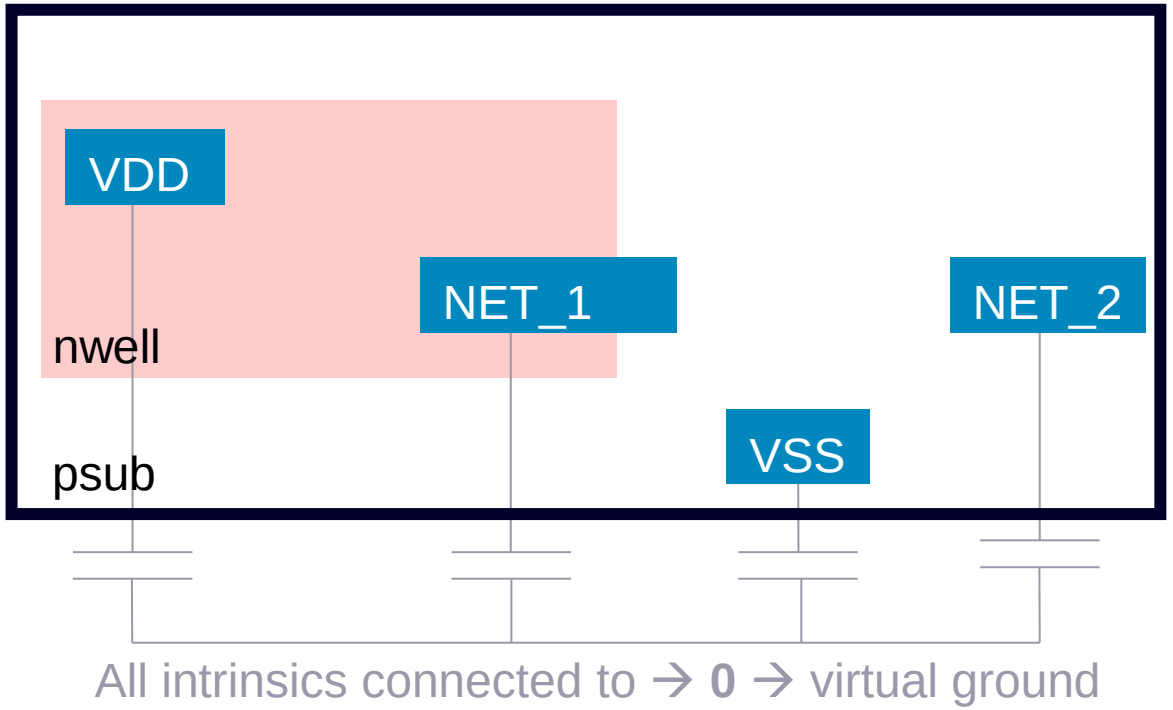
In this section, we will be investigating the expected behavior before and after setting **PEX GROUND LAYER** statement in the rule decks

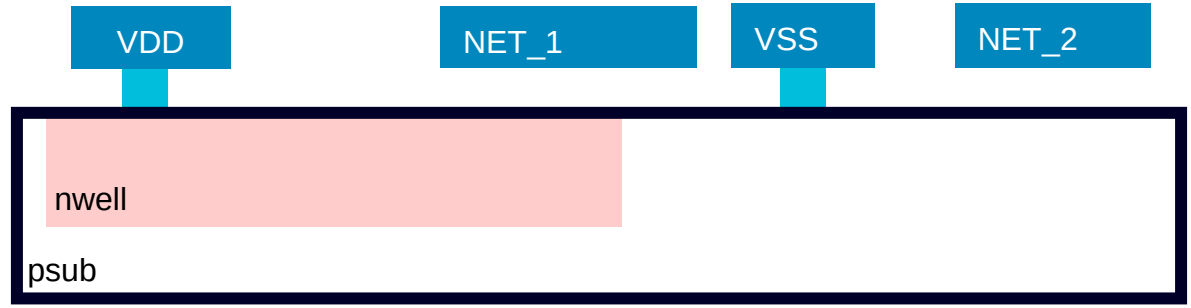
The snapshots on the right show metal1 routes in blue. Net_1 is routed over both the nwell and psub, whereas NET_2 is routed over psub only.

VDD is connected to nwell, whereas VSS is connected to psub

With PEX GROUND LAYER statement NOT defined:

- All the intrinsic capacitances will be connected to “0”



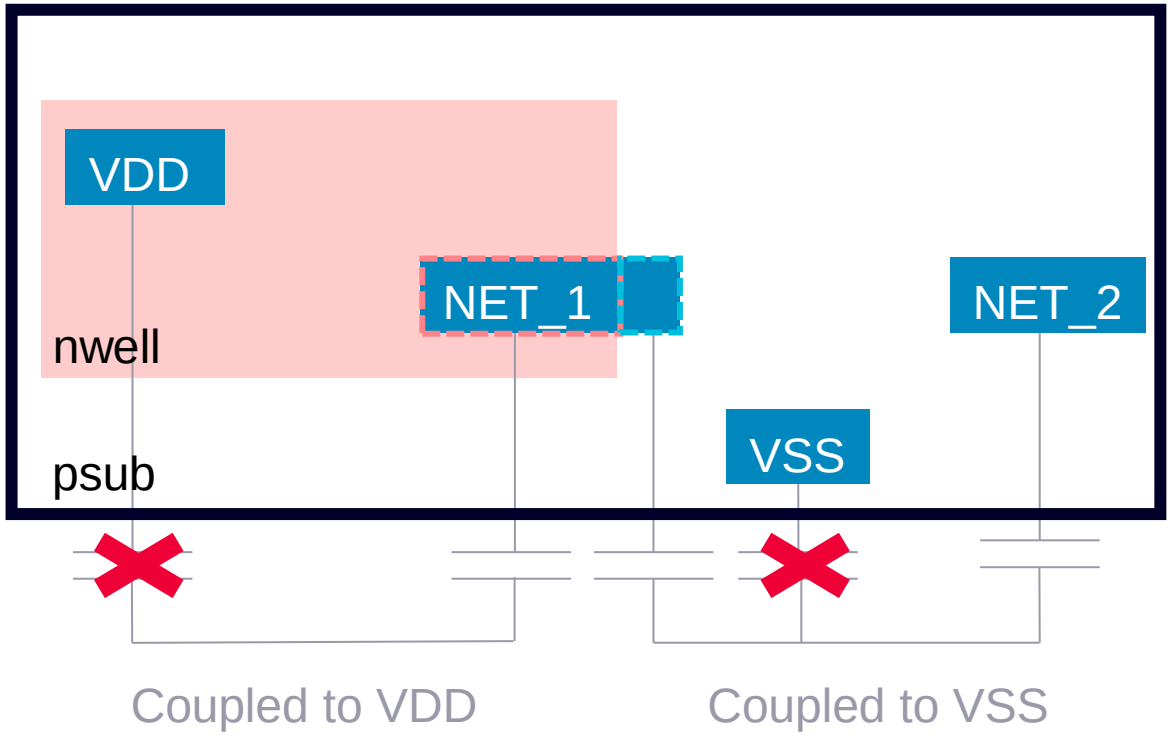


Cross-section View

Description

With **PEX GROUND LAYER nwell psub** statement:

- In the overlapping regions between the nwell and the psub, the intrinsics capacitances of nets passing over this region will be coupled to VDD (connected to nwell), since the order of the nwell in the statement gave it precedence over the psub
- The intrinsic capacitances of nets passing only over the psub will be coupled to VSS
- Intrinsic capacitance of VDD and VSS nets will not be reported since they are same net couplings



Description
>> Rule Deck

```
LAYOUT PATH "layout.gds"
LAYOUT PRIMARY "TOP"
LAYOUT SYSTEM GDSII

SOURCE PATH "source.sp"
SOURCE PRIMARY "TOP"
SOURCE SYSTEM SPICE

#IFDEF $ENABLE_PEX_GND_LAYER YES
        PEX GROUND LAYER nwell psub

#ELSE
#IFDEF $ENABLE_PEX_GND_LAYER STRAY
        PEX GROUND LAYER STRAY nwell psub

#ENDIF
#ENDIF

MASK SVDB DIRECTORY "svdb" QUERY XRC IXF NXF XDB
PEX NETLIST netlist.dspf DSPF SOURCENAMES
```

Only part of the rule deck is shown in this slide

The rule deck supports 3 settings:

- With "*ENABLE_PEX_GND_LAYER*" set to "YES", it will run with nwell and psub (substrate) as ground layers, in this corresponding order
- With "*ENABLE_PEX_GND_LAYER*" set to "STRAY" it will run with nwell and psub (substrate) as ground layers and will invoke the STRAY option to remove the stray caps
- With "*ENABLE_PEX_GND_LAYER*" set to anything but "YES" or "STRAY", it will run without **PEX GROUND LAYER**

Description
>> runme

```
setenv ENABLE_PEX_GND_LAYER NO
$MGC_HOME/bin/calibre -lvs -hier -hcell hcells.txt top-rules.xrc |
& tee lvs.log
$MGC_HOME/bin/calibre -xrc -pdb -rcc top-rules.xrc |& tee pdb.log
$MGC_HOME/bin/calibre -xrc -fmt -c top-rules.xrc |& tee fmt.log
source mv-results.csh

setenv ENABLE_PEX_GND_LAYER YES
$MGC_HOME/bin/calibre -lvs -hier -hcell hcells.txt top-rules.xrc |
& tee lvs.log
$MGC_HOME/bin/calibre -xrc -pdb -rcc top-rules.xrc |& tee pdb.log
$MGC_HOME/bin/calibre -xrc -fmt -c top-rules.xrc |& tee fmt.log
source mv-results.csh

setenv ENABLE_PEX_GND_LAYER STRAY
$MGC_HOME/bin/calibre -lvs -hier -hcell hcells.txt top-rules.xrc |
& tee lvs.log
$MGC_HOME/bin/calibre -xrc -pdb -rcc top-rules.xrc |& tee pdb.log
$MGC_HOME/bin/calibre -xrc -fmt -c top-rules.xrc |& tee fmt.log
source mv-results.csh
```

The runme invokes 3 runs:

- With "*ENABLE_PEX_GND_LAYER*" set to NO, it will run without **PEX GROUND LAYER**
- With "*ENABLE_PEX_GND_LAYER*" set to "YES", it will run with nwell and psub (substrate) as ground layers, in this corresponding order
- With "*ENABLE_PEX_GND_LAYER*" set to "STRAY" it will run with nwell and psub (substrate) as ground layers and will invoke the STRAY option to remove the stray caps

Description
>> runme

```
setenv ENABLE_PEX_GND_LAYER NO
$MGC_HOME/bin/calibre -lvs -hier -hcell hcells.txt top-rules.xrc |
& tee lvs.log
$MGC_HOME/bin/calibre -xrc -pdb -rcc top-rules.xrc |& tee pdb.log
$MGC_HOME/bin/calibre -xrc -fmt -c top-rules.xrc |& tee fmt.log
source mv-results.csh

setenv ENABLE_PEX_GND_LAYER YES
$MGC_HOME/bin/calibre -lvs -hier -hcell hcells.txt top-rules.xrc |
& tee lvs.log
$MGC_HOME/bin/calibre -xrc -pdb -rcc top-rules.xrc |& tee pdb.log
$MGC_HOME/bin/calibre -xrc -fmt -c top-rules.xrc |& tee fmt.log
source mv-results.csh

setenv ENABLE_PEX_GND_LAYER STRAY
$MGC_HOME/bin/calibre -lvs -hier -hcell hcells.txt top-rules.xrc |
& tee lvs.log
$MGC_HOME/bin/calibre -xrc -pdb -rcc top-rules.xrc |& tee pdb.log
$MGC_HOME/bin/calibre -xrc -fmt -c top-rules.xrc |& tee fmt.log
source mv-results.csh
```

After every xRC run, runme file invokes the mv-results.csh scripts, which:

- Renames the svdb and output netlist with respect to *ENABLE_PEX_GND_LAYER* variable
- Creates a directory with respect to *ENABLE_PEX_GND_LAYER* variable name and moves the database, netlist and log files into it

Directions

- From the terminal, execute the runme file:

```
source ./runme
```

- For the coming section, you will be directed into opening the Standard Verification Database (SVDB) created by each run through Calibre Results Viewing Environment (RVE)

- We will investigate the extracted cap values for nets NET_1, NET_2 and VDD

- Please make sure that you close the opened netlist after each results view in order to proceed to the next step: viewing the SVDB of the next run in-line

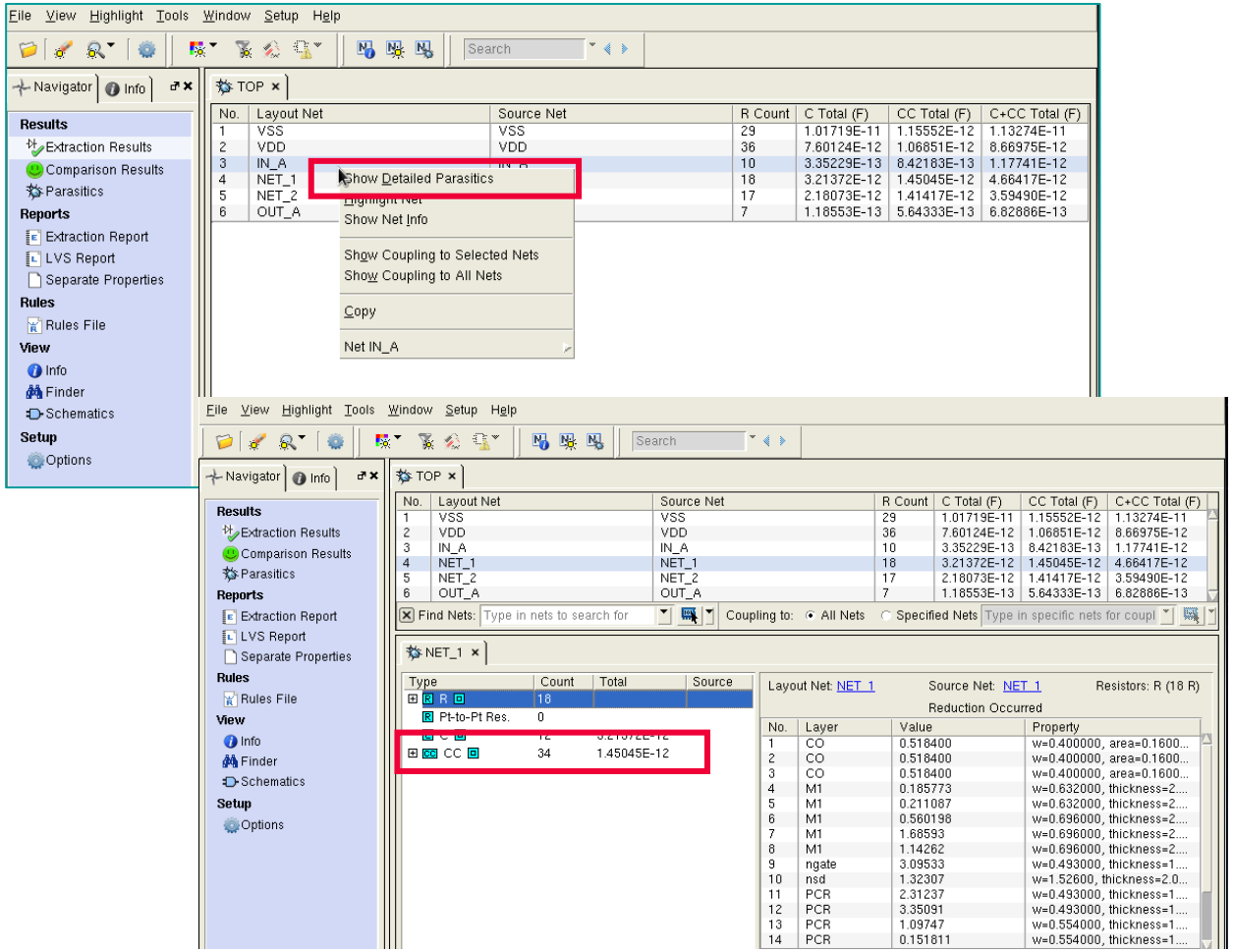
Directions
>> Results without PEX GROUND LAYER

- From the terminal, open the svdb created without **PEX GROUND LAYER**

```
calibre -rve
PEX_GND_LAYER_NO/svdb.PEX_GND_LAYER_NO
```

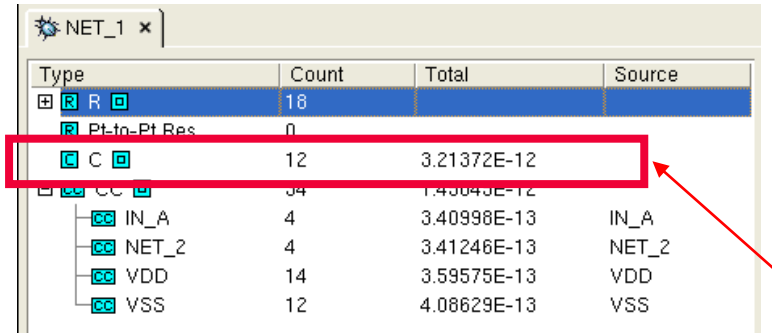
- Once RVE loads, right click on any of the nets and click on “Show Detailed Parasitics” to see more details on the extracted capacitance values

- One the net details pop-up, expand the cc list to the nets that each of the investigated nets couple to

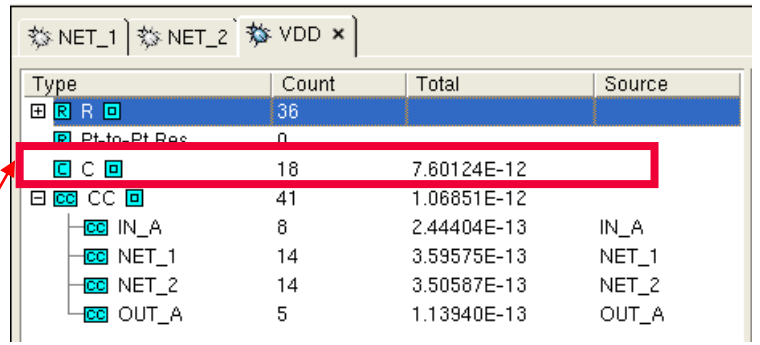


Directions
>> Results without PEX GROUND LAYER

- NET_1

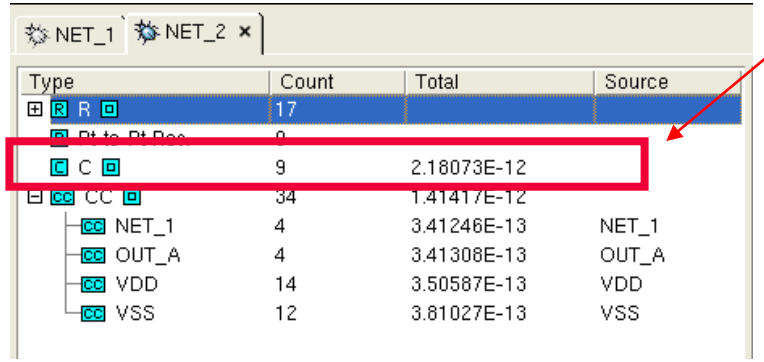


- VDD



Intrinsic capacitances to 0

- NET_2

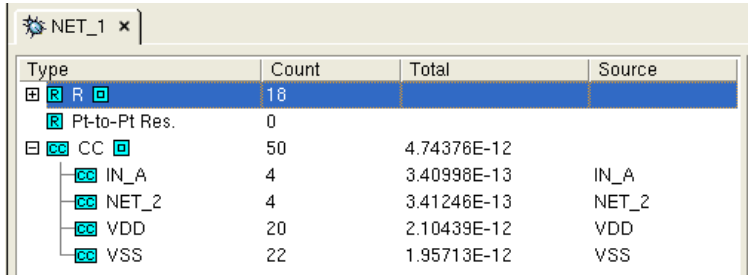


Directions
>> Results with PEX GROUND LAYER nwell psub

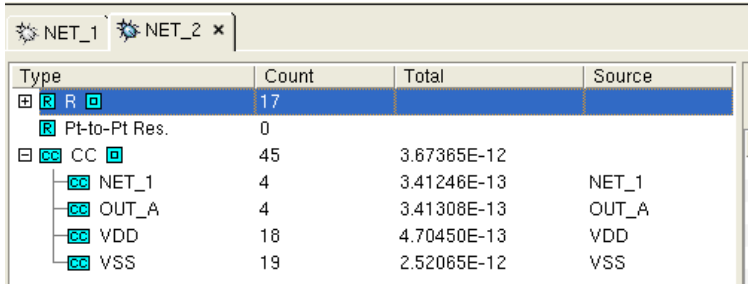
- From the terminal, open the svdb created with **PEX GROUND LAYER nwell psub**

```
calibre -rve
PEX_GND_LAYER_YES/svdb.PEX_GND_LAYER_YES
```

- NET_1



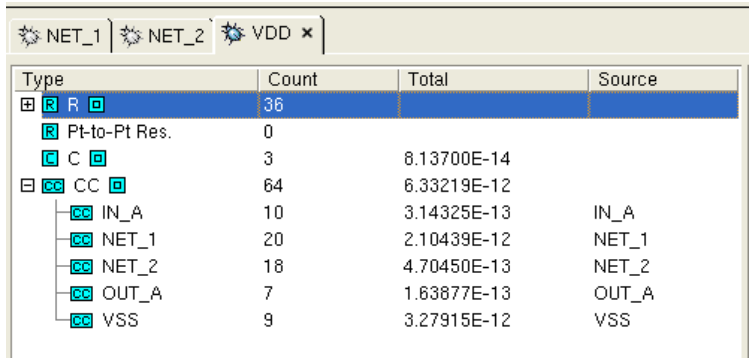
- NET_2



- For nets NET_1 and NET_2, note the following:
  - All the intrinsic caps to 0 are gone
  - Increase in cc values to VSS and VDD

    → All the intrinsics are converted to couplings to VSS and VDD

- VDD



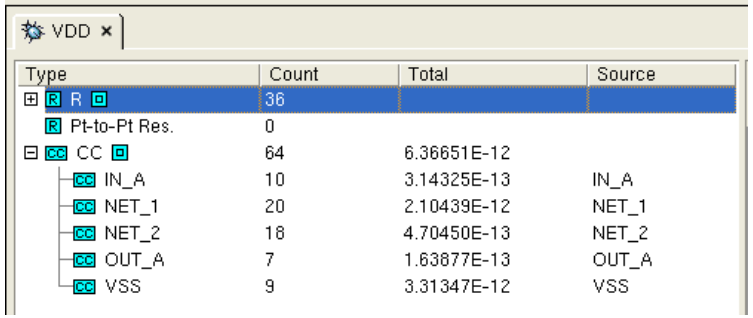
  - Some stray intrinsic capacitances are left
  - Overall increase in total cc values, since all of the intrinsic capacitances of other nets that pass over nwell are converted into couplings to VDD

Directions
>> Results with PEX GROUND LAYER STRAY nwell psub

- From the terminal, open the svdb created with **PEX GROUND LAYER STRAY nwell psub**

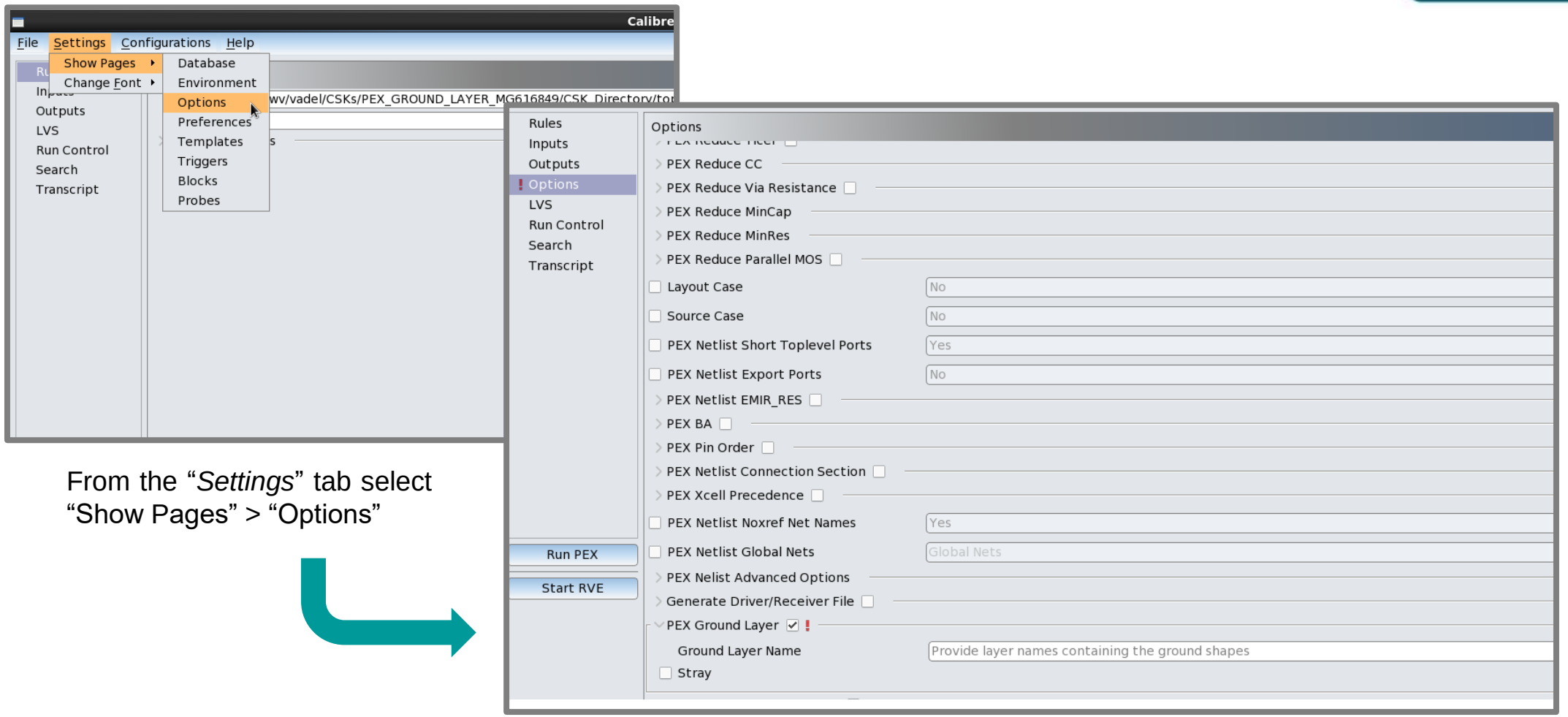
```
calibre -rve
PEX_GND_LAYER_STRAY/svdb.PEX_GND_LAYER_STRAY
```

- VDD



  - All stray intrinsic capacitances are eliminated

How to Setup PEX GROUND LAYER in Calibre xRC New GUI



From the “*Settings*” tab select “Show Pages” > “Options”

From the “options” tab, select “PEX Ground Layer”, then specify your layers and select the “Stray” option

Conclusion

PEX GROUND LAYER is used to define the layers associated to ground nets

If the design has multiple grounds, these ground layers could be added the **PEX GROUND LAYER** command to calculate the accurate coupling to each ground net

The order of the ground layers in the **PEX GROUND LAYER** command determines the precedence of coupling capacitance to ground net assignment in case of overlap between multiple ground layers

Please refer to the **Standard Verification Rule Format (SVRF) Manual** for additional information

Support Center: https://support.sw.siemens.com/
Send Feedback on Documentation: https://support.sw.siemens.com/doc_feedback_form