AMERICAN UNIVERSITY OF BEIRUT

# Virtuoso 23.1
# Module 12 – Post-Layout Simulations

American University of Beirut (AUB)
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# Contents







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# Module Objective

In this module, we will learn how to use the extracted view to simulate the circuit with the parasitics.

# 1. Setting up the Configuration View

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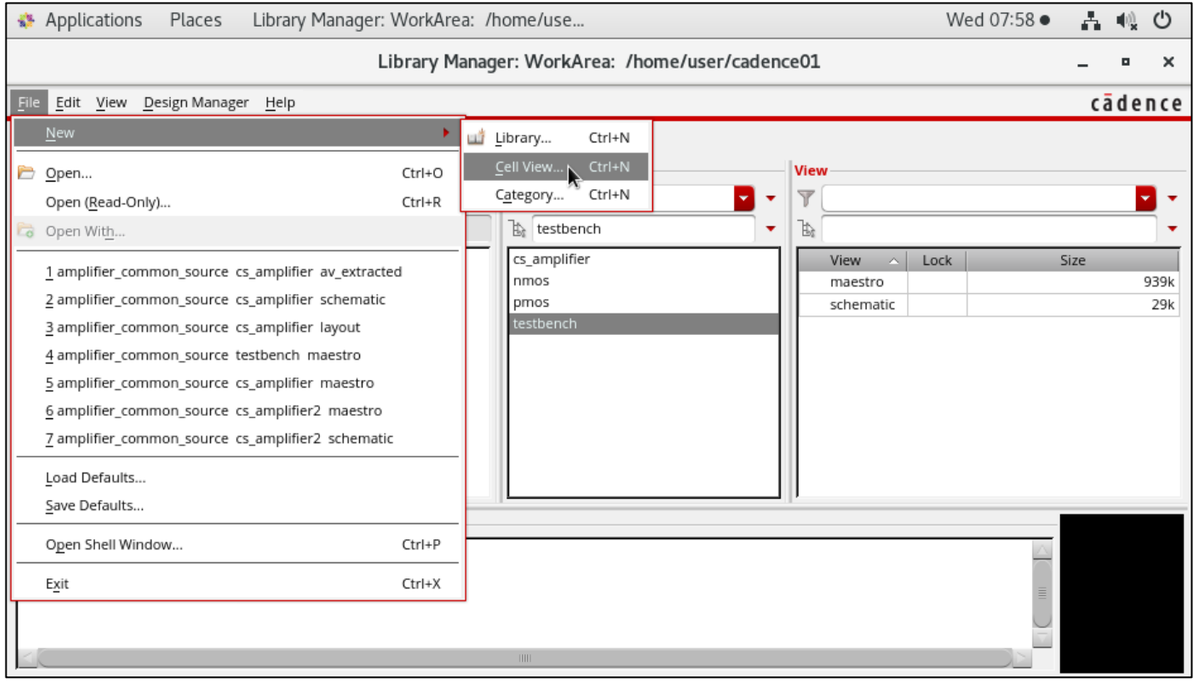
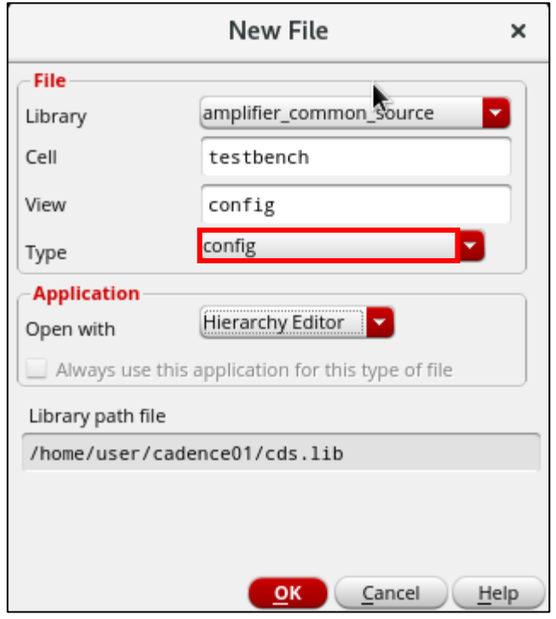
- Configuration View
- Testbench Modification
- DC and AC Analysis
- Measurements Across Sweeps and Corners
- Monte Carlo Analysis

# 1. Setting up the Configuration View

- First, we must set a new configuration to our symbol view. From the **Library Manager**, click on the library **amplifier_common_source**, then click on the **testbench** cell, then **File → New → Cell View...**
- Change the Type to **"config"**, and make sure the Library and the Cell fields are as shown below.



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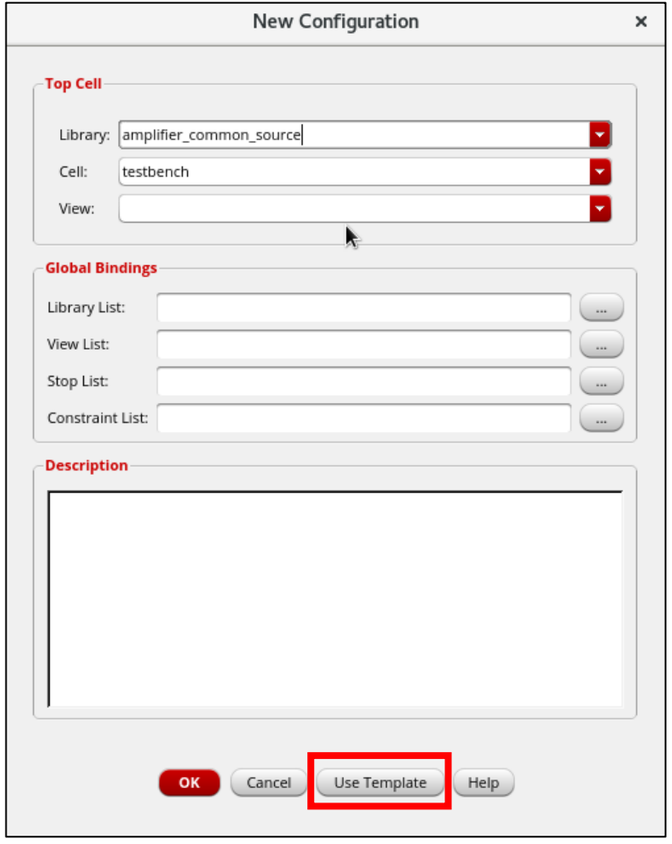
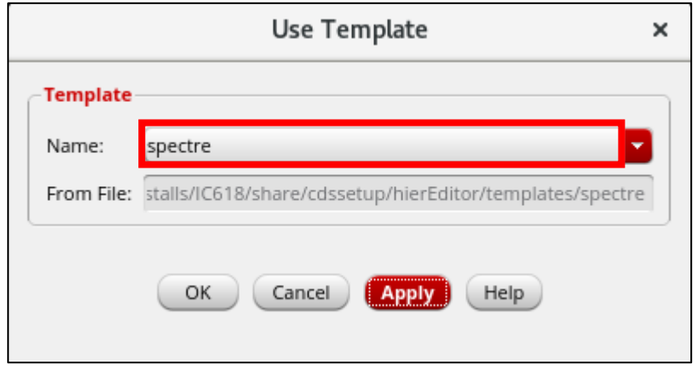
# 1. Setting up the Configuration View *(continued)*

- The New Configuration window opens.
- Click on **Use Template**. From the drop-down list of the “Name” field choose **spectre**.







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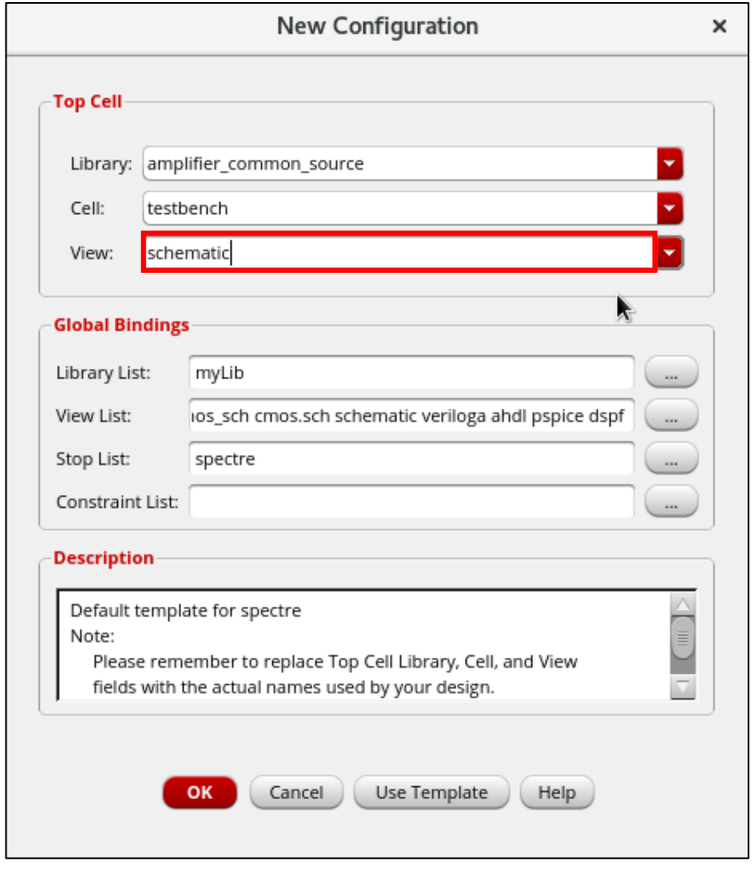
# 1. Setting up the Configuration View *(continued)*

- Change the View to **schematic** and click OK.







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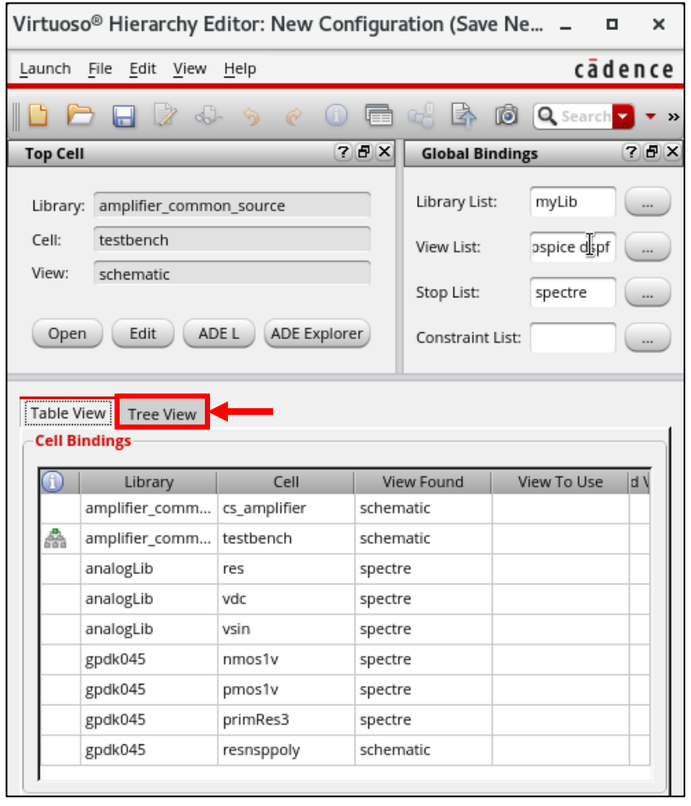
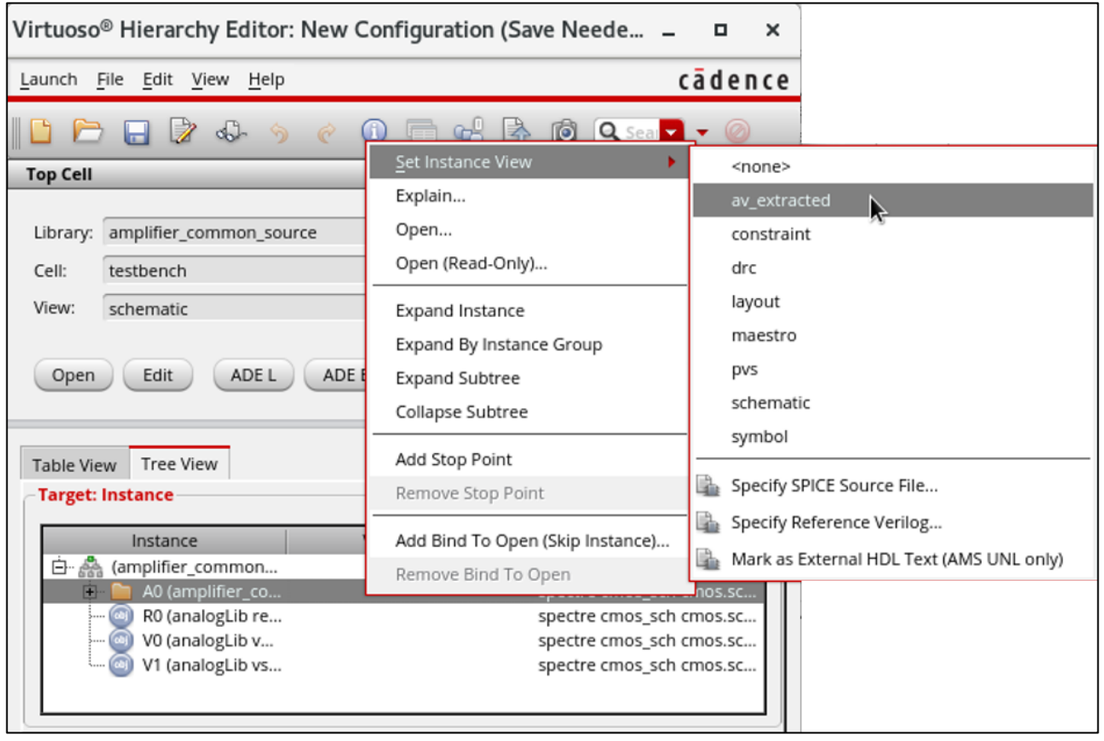
# 1. Setting up the Configuration View *(continued)*

- From the Virtuoso Hierarchy Editor, click on **Tree View**.
- Right click on the folder A0(amplifier_common_source cs_amplifier schematic) → Set Instance View → **av_extracted**.



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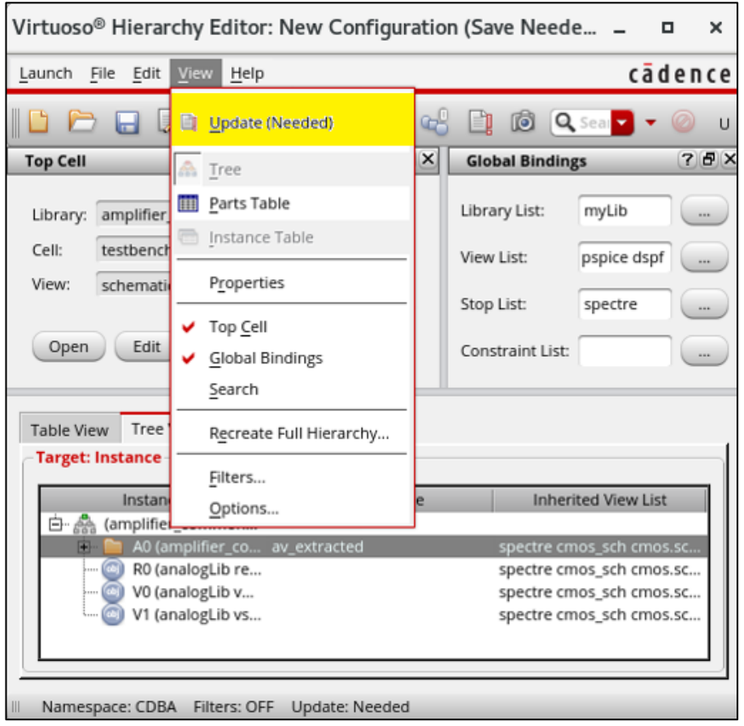
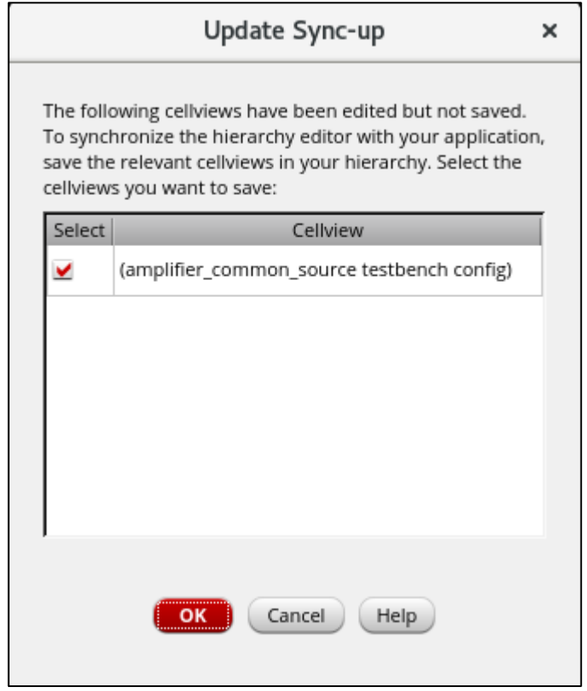
# 1. Setting up the Configuration View *(continued)*

- To update the config file, click on View → Update (Needed).
- The Update Sync-up window pops-up, Click OK, and Save the config file.



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# 2. Testbench Modification

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- **Testbench Modification**
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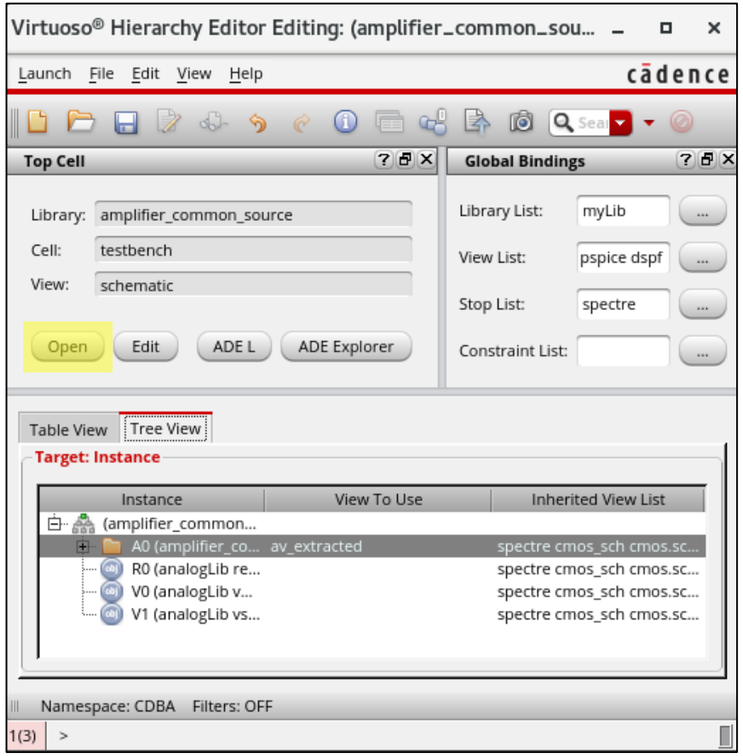
# 2. Testbench Modification

- To open the schematic of the testbench, click on Open (it might take a minute).







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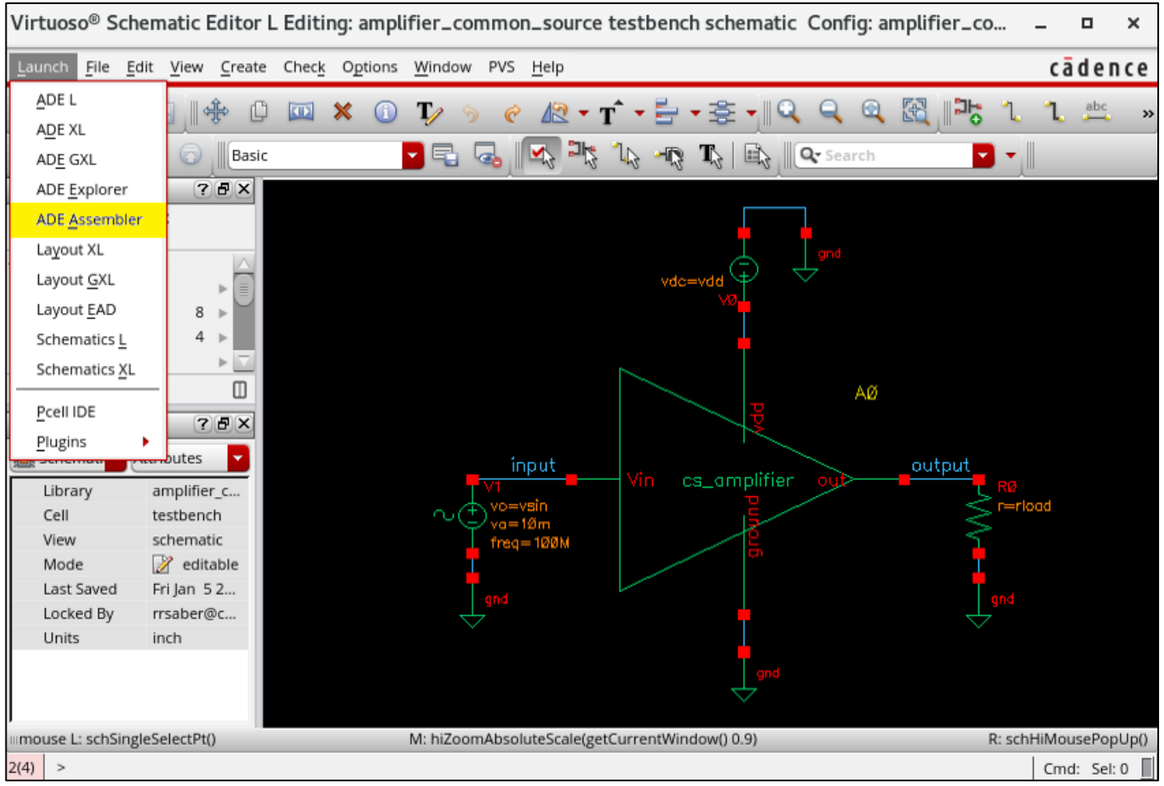
# 2. Testbench Modification *(continued)*

- To simulate the circuit, we will use the tool ADE Assembler. Click Launch → ADE Assembler.



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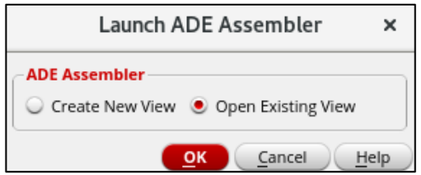
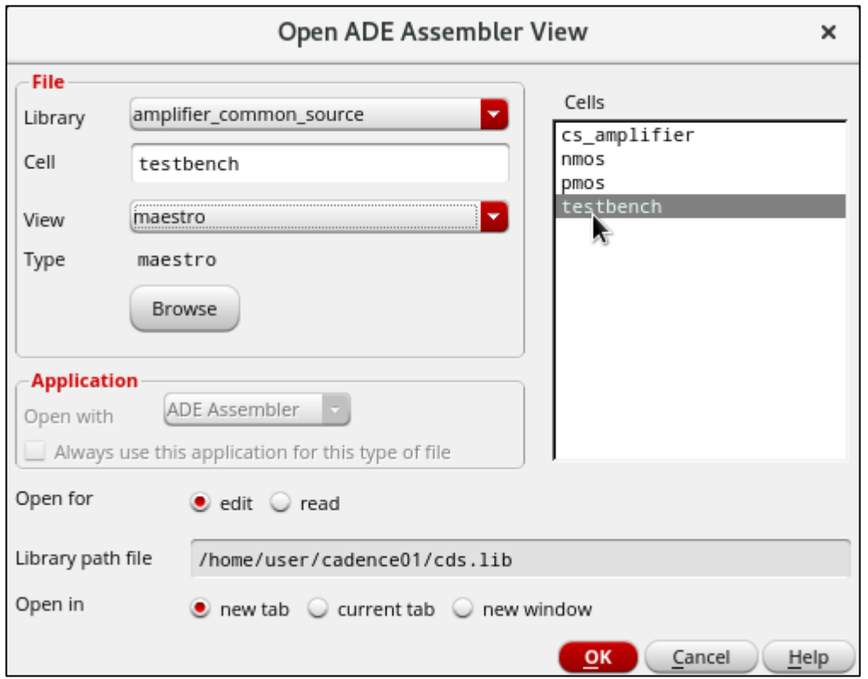
# 2. Testbench Modification *(continued)*

- The Launch ADE Assembler from opens, choose “Open Existing View”, and click OK.
- Make sure the Cell is set to testbench and the View to maestro.
- Click OK to open the tests.







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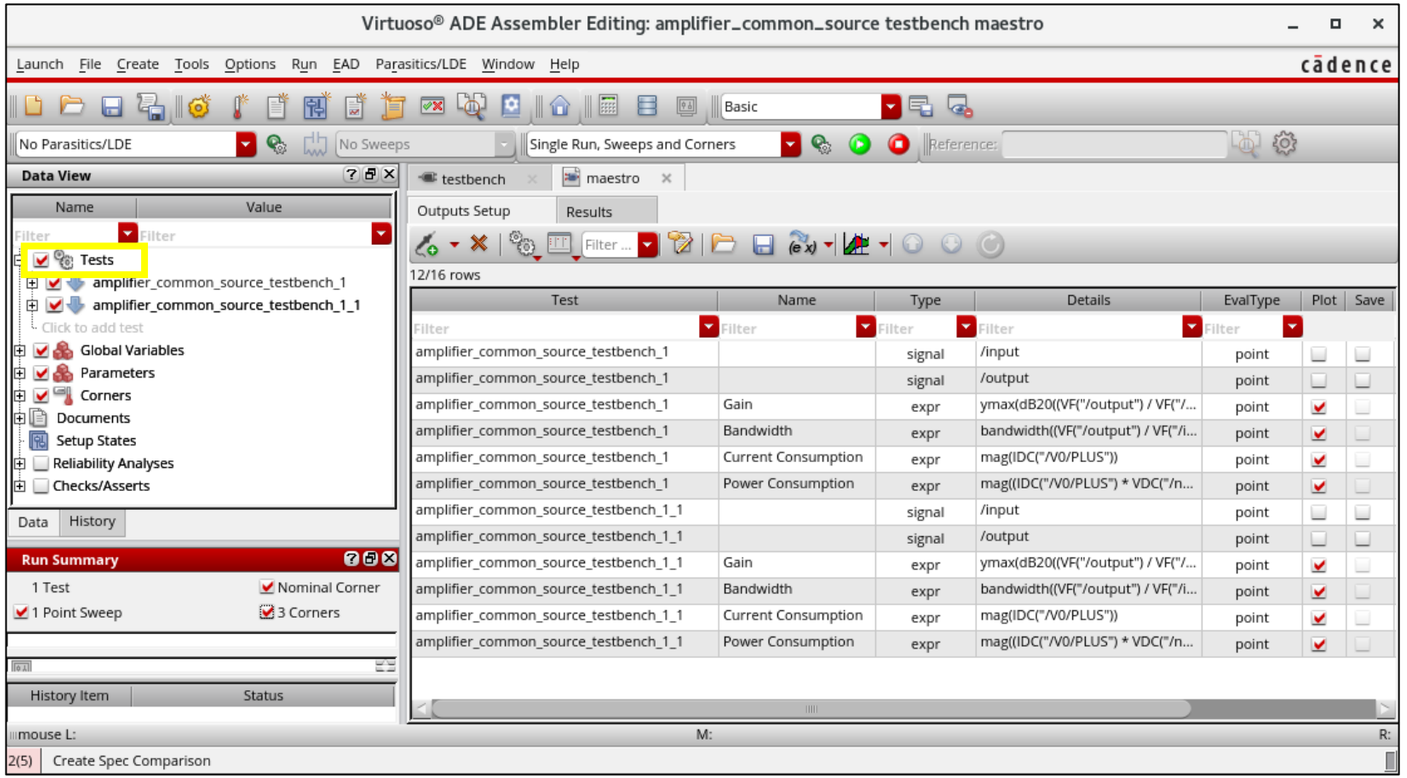
# 2. Testbench Modification *(continued)*

- Notice the tab maestro along with the tab testbench.
- Expand the tab Tests. Notice we already have a copy of the original testbench.
- We will rename the Tests to “testbench_pre_layout” and “testbench_post_layout”.







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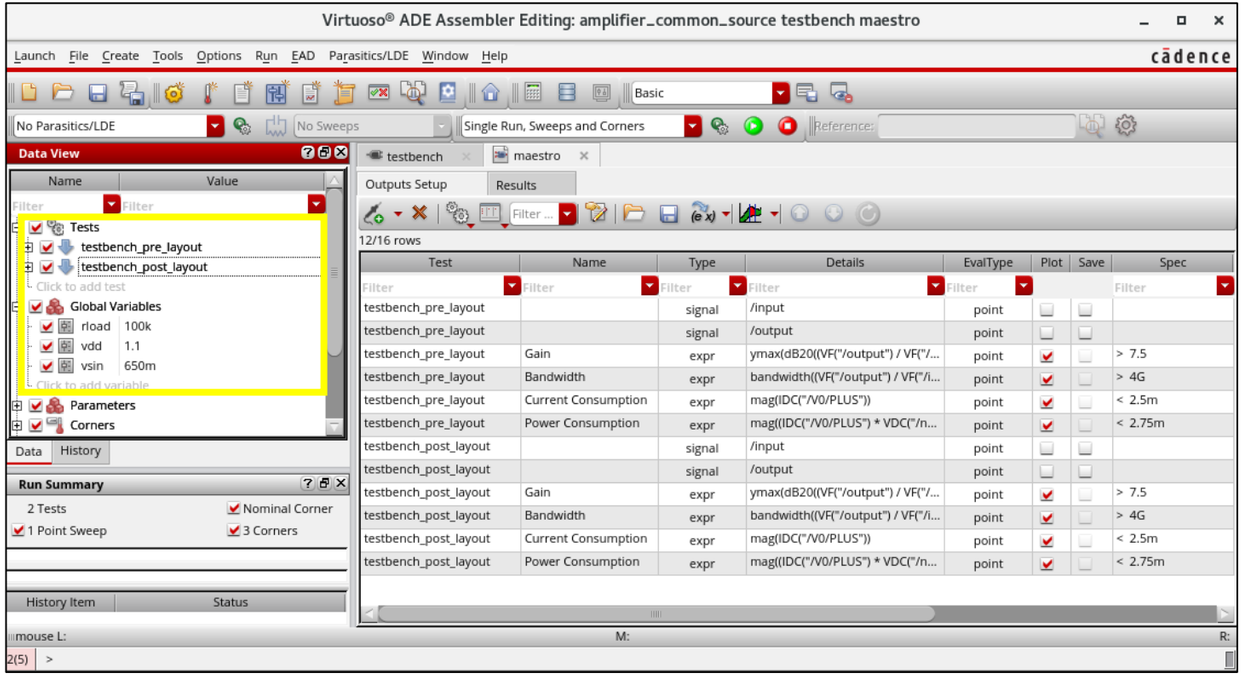
# 2. Testbench Modification *(continued)*

- Select the test “amplifier_common_source_testbench_1” and left-click once to rename it to “testbench_pre_layout”.
- Select the test “amplifier_common_source_testbench_1_1” and left-click once to rename it to “testbench_post_layout”.
- Note that if by mistake you switched to ADE Explorer, click on the blue arrow to switch back to ADE Assembler. Also, make sure to check the Global Variables.



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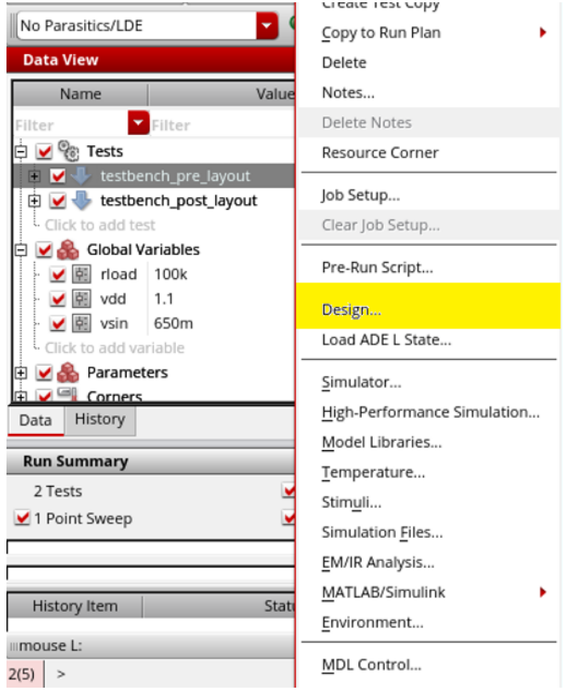
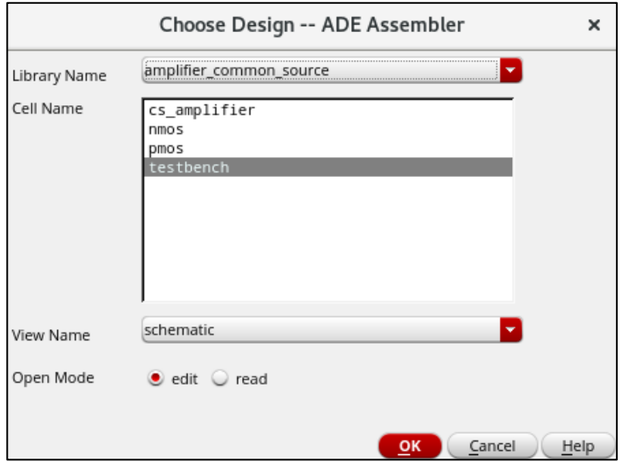
# 2. Testbench Modification *(continued)*

- Select the test "**testbench_pre_layout**", right-click and select Design.
- The Choose Design – ADE Assembler form opens.
- Make sure the View Name is set to **schematic**. Click OK.
- Select the test again, right-click and select Model Libraries. Make sure the "**gpdk045.scs**" file is selected, and the **section** is set to **tt**.




- Note that if the Model Libraries are not defined, please check Module 3 slide 14.



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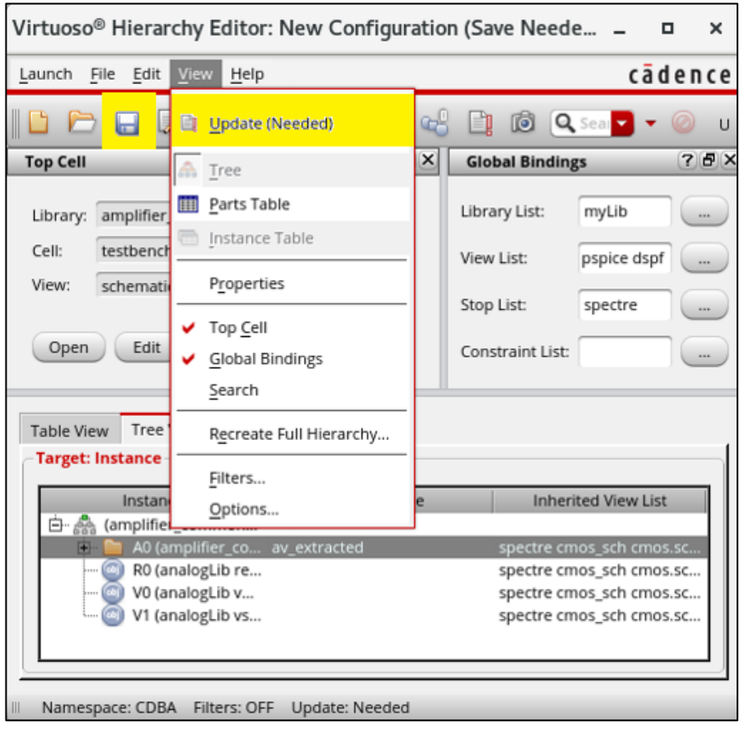
# 2. Testbench Modification *(continued)*

- From the taskbar, open the Virtuoso Hierarchy Editor.
- Click on View → Update (Needed) and save the config file.




- Note that we need to update and save the config file when we make modifications.



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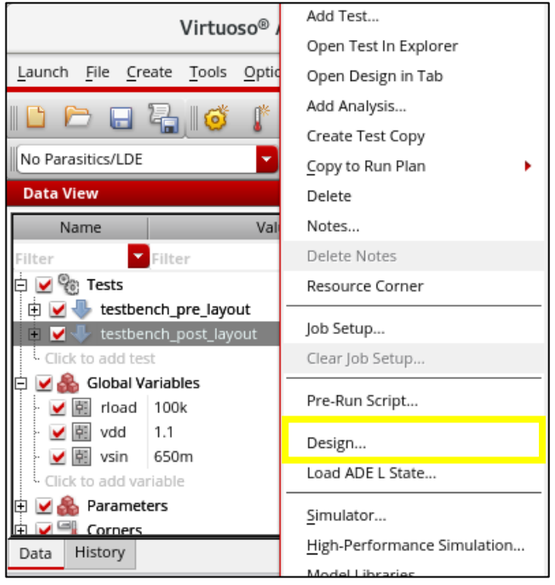
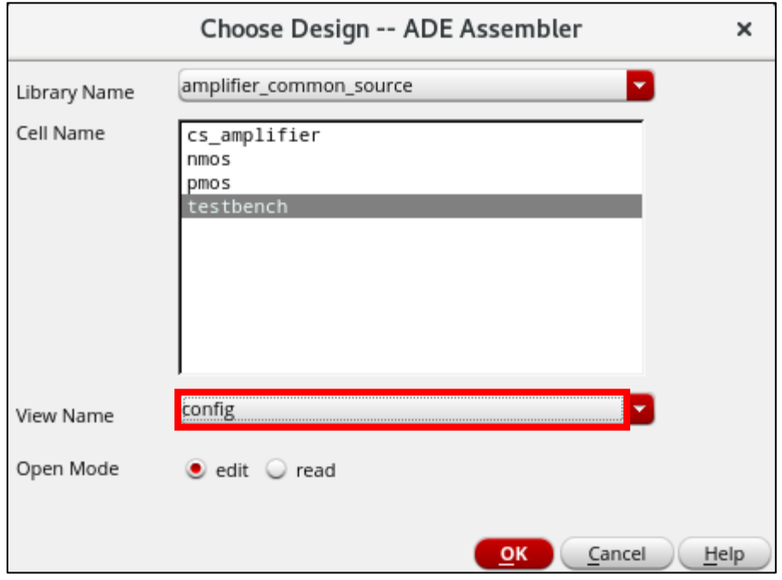
# 2. Testbench Modification *(continued)*

- Select the test "**testbench_post_layout**", right-click and select Design.
- The Choose Design – ADE Assembler form opens.
- Change the View Name to **config**.
- Select the test again, right-click and select Model Libraries. Make sure the "**gpdk045.scs**" file is selected, and the **section** is set to **tt**.




- Since the av_extracted file was set in the config file, we choose the View Name "config" for the post-layout simulations.
- Note that if the Model Libraries are not defined, please check Module 3 slide 14.

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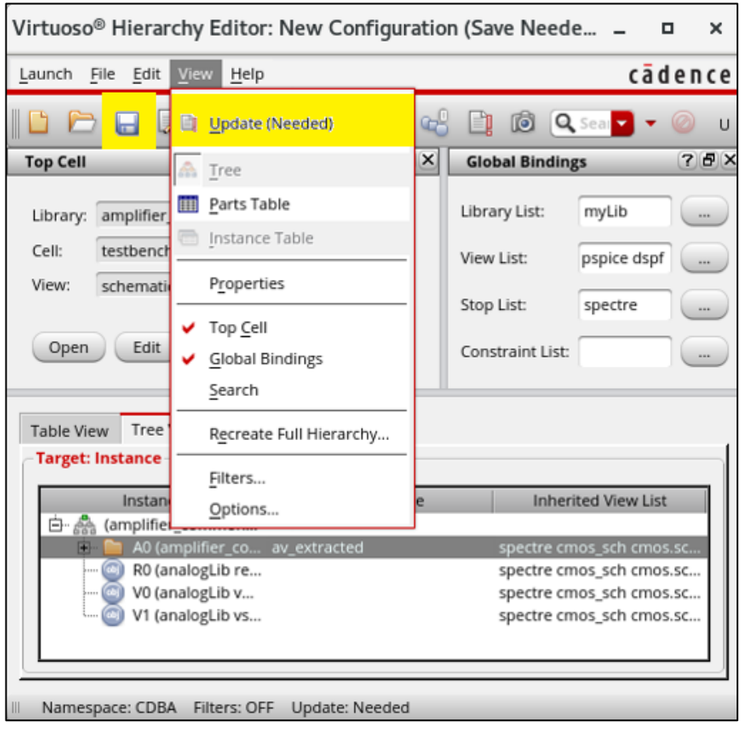
# 2. Testbench Modification *(continued)*

- From the taskbar, open the Virtuoso Hierarchy Editor.
- Click on View → Update (Needed) and save the config file.




- Note that we need to update and save the config file when we make modifications.



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# 3. DC and AC Analysis

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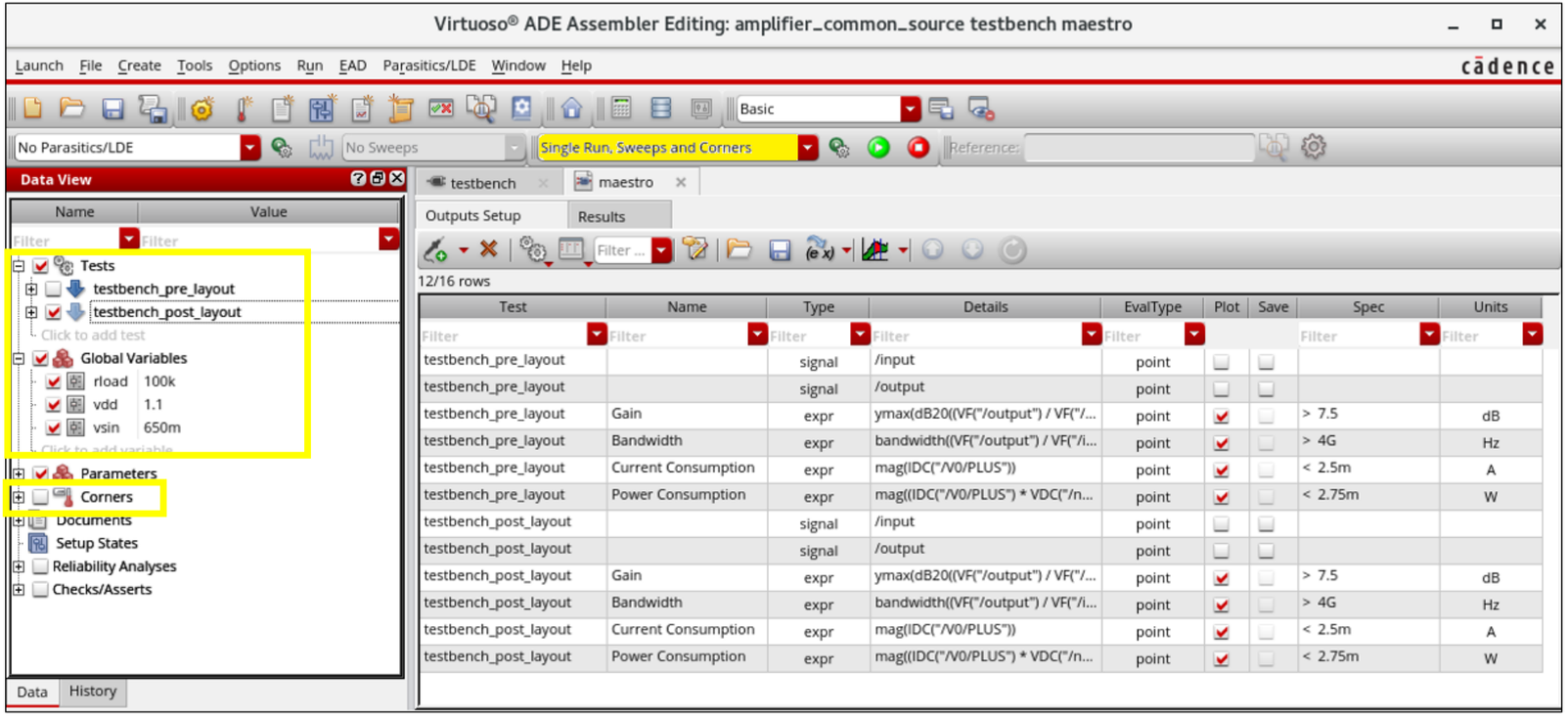
# 3. DC and AC Analysis

- Uncheck the test “**testbench_pre_layout”**, since we want to run the analyses only for the post-layout now.
- Make sure the test “**testbench_post_layout”** is enabled.
- Uncheck Corners, and select Single Run, Sweeps and Corners from the drop-down list.
- Make sure to uncheck **Enable Electrical data Capture from EAD Flow** in EAD → setup…







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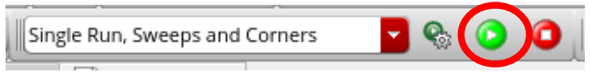
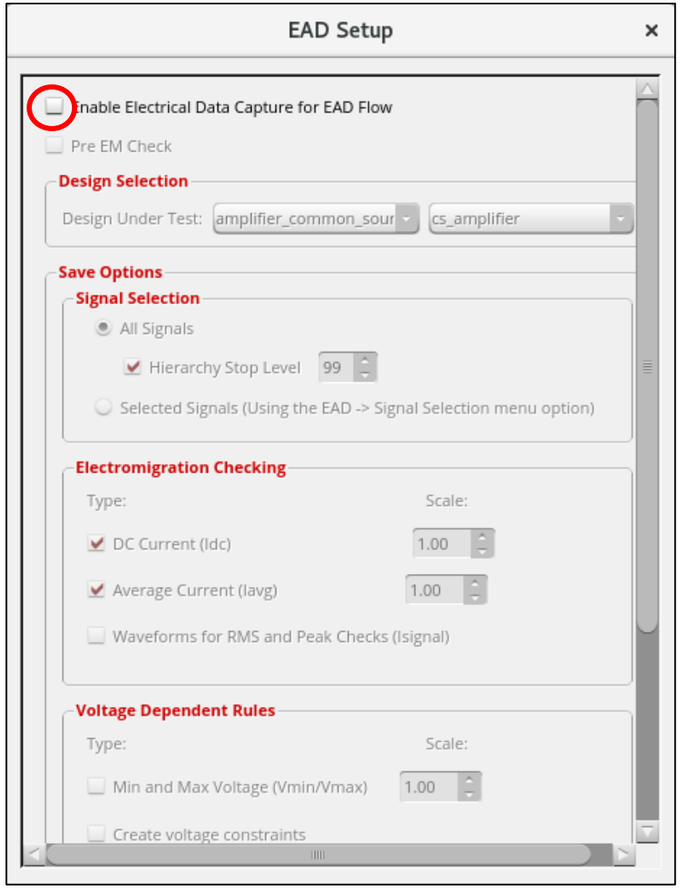
# 3. DC and AC Analysis

- EAD setup should look like this before running the simulation.
- Press on OK to close EAD Setup.
- Run the simulation.







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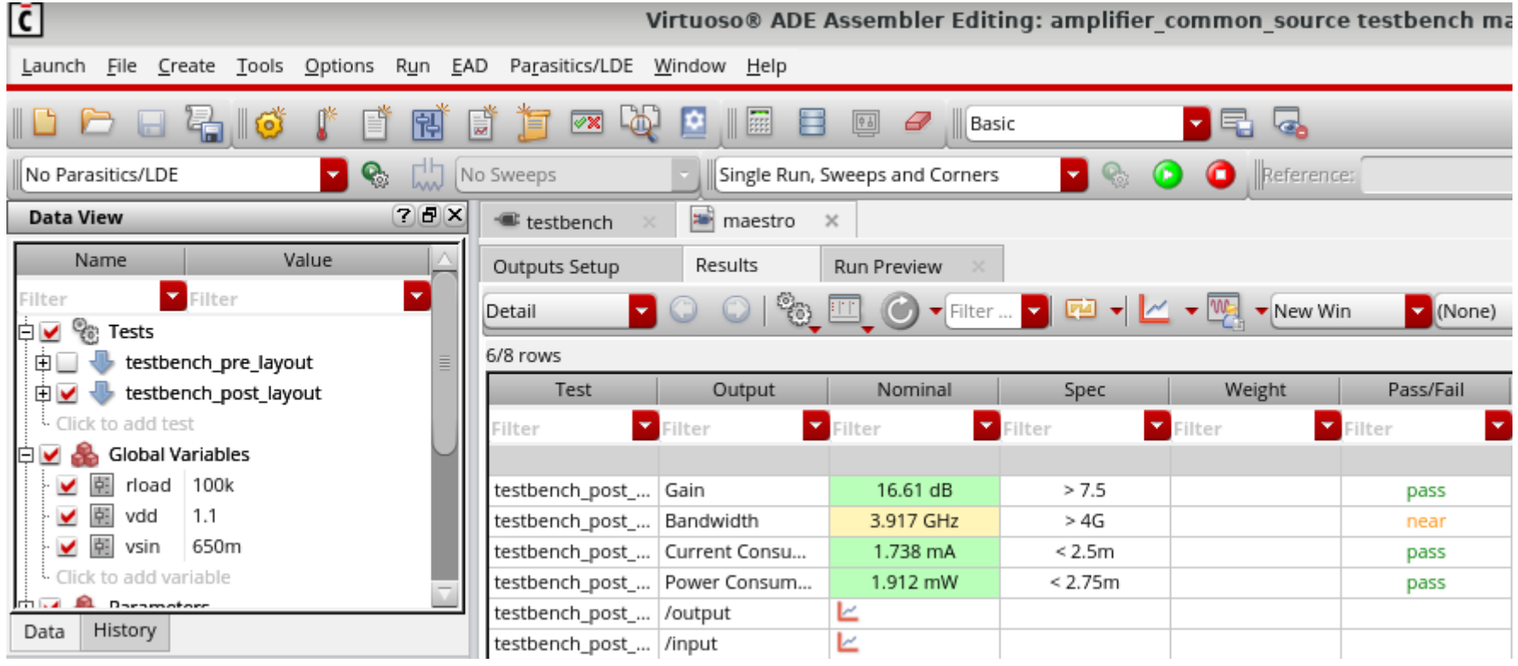
# 3. DC and AC Analysis *(continued)*

- ADE Assembler automatically switches to the Results tab.
- The results are shown below.







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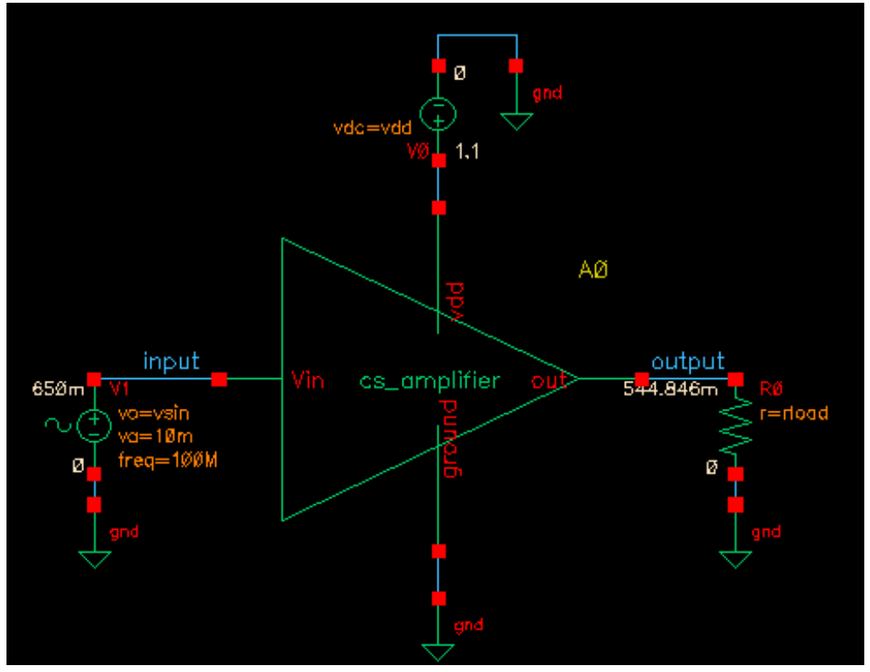
# 3. DC and AC Analysis *(continued)*

- To view the DC Node Voltages and Operating Points, from the **Results** tab, select any result and right-click → Results → Annotate → DC Node Voltages and DC Operating Points.
- ADE Assembler switches automatically to the testbench tab showing the DC Node Voltages and Operating Points.







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# 4. Measurements Across Sweeps and Corners




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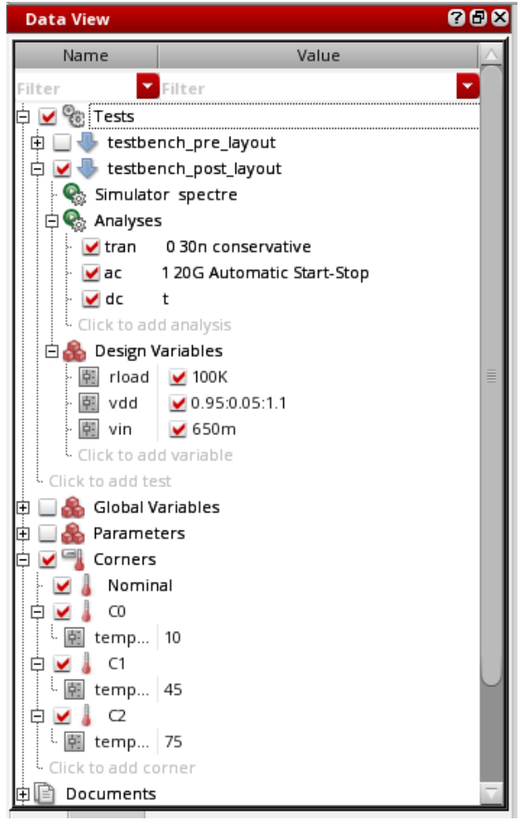
# 4. Measurements Across Sweeps and Corners

- To run the simulation across sweeps and corners, we have to define the sweeps and corners.
- Note since we are using a copy of the original testbench used in Module 4, the corners are set.
- Uncheck the Global Variables.
- Check the Corners.
- Expand the test “testbench_post_layout”, the Analysis, and the Design Variables.
- Make sure to have the setup as shown in the figure.
- Run the simulation.







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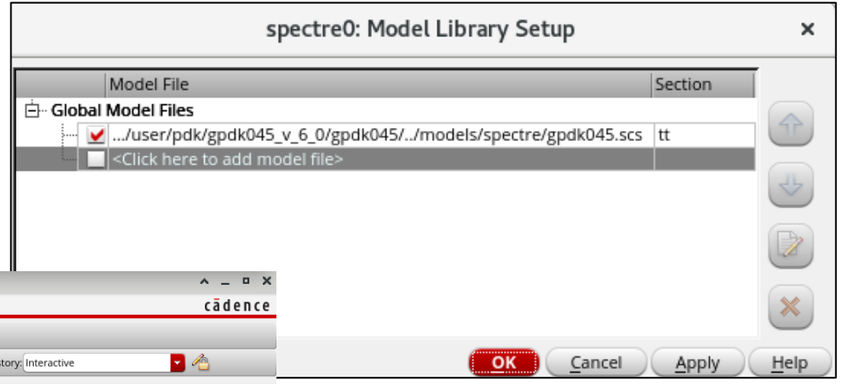
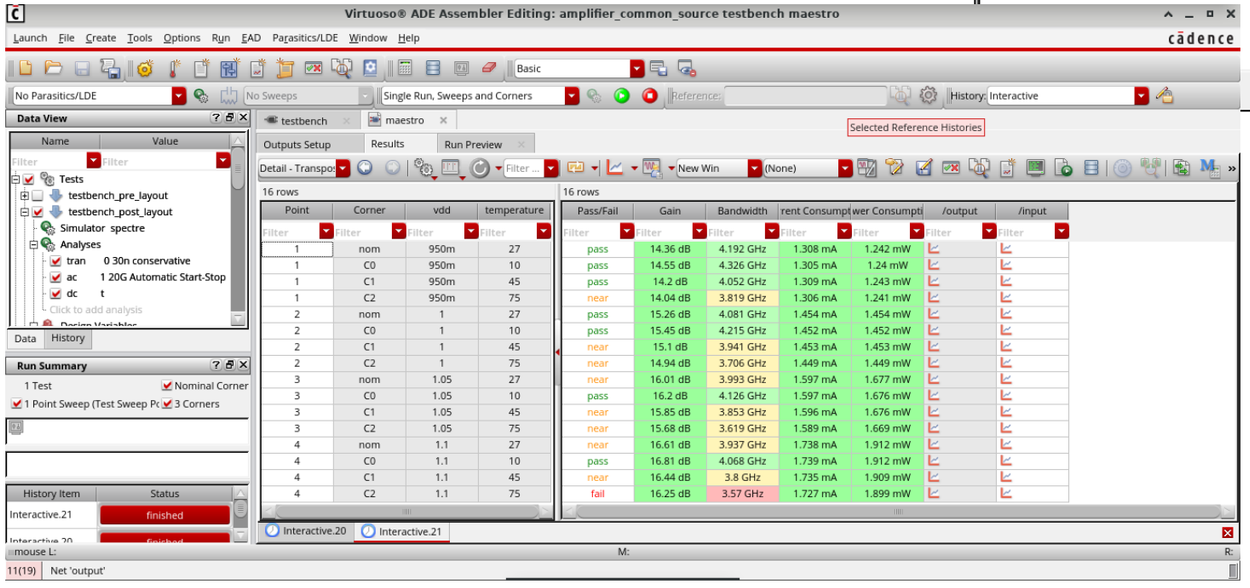
# 4. Measurements Across Sweeps and Corners *(continued)*

- The results are displayed for the "**tt**" process corners.
- The gain is better for higher vdd values.
- The current and power consumption pass the given specs.
- As for the bandwidth, the parasitics have affected the results.



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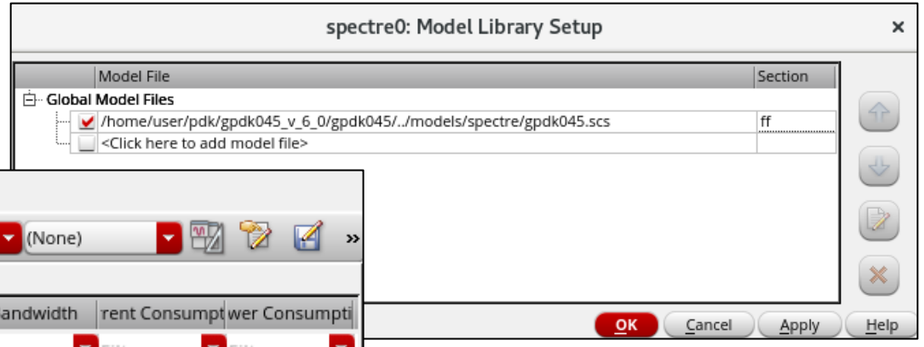
# 4. Measurements Across Sweeps and Corners *(continued)*

- Select the test “testbench_post_layout” from the Data View. Right-click and select Model Libraries. Change the section to “**ff**” and run the simulation.
- The results are shown below.




Outputs Setup | Results

Detail - Transpose | Filter ... | New Win | (None)

16 rows

| Point | Corner | vdd | temperature | Pass/Fail | Gain | Bandwidth | rent Consumpt | wer Consumpti |
|---|---|---|---|---|---|---|---|---|
| 1 | nom | 950m | 27 | pass | 13 dB | 5.991 GHz | 1.906 mA | 1.811 mW |
| 1 | C0 | 950m | 10 | pass | 13.05 dB | 6.358 GHz | 1.917 mA | 1.821 mW |
| 1 | C1 | 950m | 45 | pass | 12.95 dB | 5.681 GHz | 1.894 mA | 1.799 mW |
| 1 | C2 | 950m | 75 | pass | 12.9 dB | 5.255 GHz | 1.869 mA | 1.775 mW |
| 2 | nom | 1 | 27 | pass | 13.85 dB | 5.806 GHz | 2.107 mA | 2.107 mW |
| 2 | C0 | 1 | 10 | pass | 13.93 dB | 6.142 GHz | 2.12 mA | 2.12 mW |
| 2 | C1 | 1 | 45 | pass | 13.78 dB | 5.536 GHz | 2.091 mA | 2.091 mW |
| 2 | C2 | 1 | 75 | pass | 13.71 dB | 5.126 GHz | 2.061 mA | 2.061 mW |
| 3 | nom | 1.05 | 27 | pass | 14.57 dB | 5.679 GHz | 2.304 mA | 2.42 mW |
| 3 | C0 | 1.05 | 10 | pass | 14.67 dB | 5.96 GHz | 2.321 mA | 2.437 mW |
| 3 | C1 | 1.05 | 45 | pass | 14.48 dB | 5.424 GHz | 2.285 mA | 2.4 mW |
| 3 | C2 | 1.05 | 75 | pass | 14.36 dB | 5.036 GHz | 2.25 mA | 2.362 mW |
| 4 | nom | 1.1 | 27 | pass | 15.16 dB | 5.593 GHz | 2.499 mA | 2.749 mW |
| 4 | C0 | 1.1 | 10 | near | 15.3 dB | 5.835 GHz | 2.519 mA | 2.771 mW |
| 4 | C1 | 1.1 | 45 | pass | 15.04 dB | 5.356 GHz | 2.476 mA | 2.724 mW |
| 4 | C2 | 1.1 | 75 | pass | 14.87 dB | 4.994 GHz | 2.435 mA | 2.678 mW |



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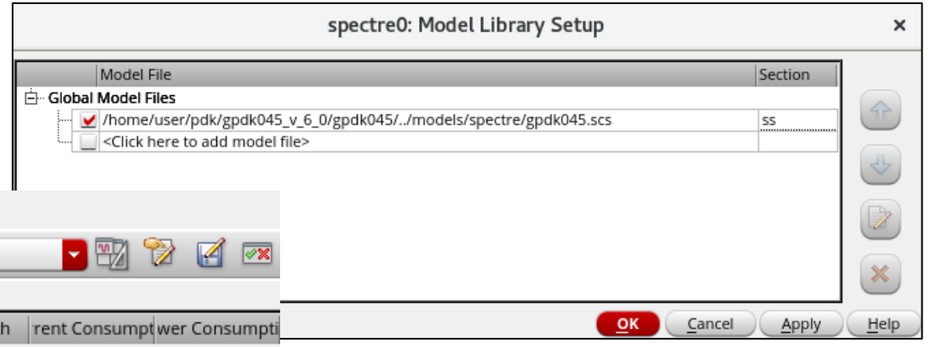
# 4. Measurements Across Sweeps and Corners *(continued)*

- Select the test “testbench_post_layout” from the Data View. Right-click and select Model Libraries. Change the section to “**ss**” and run the simulation.
- The bandwidth fails in all cases.
- The results are shown below.




Outputs Setup | Results

Detail - Transpos | Filter ... | New Win | (None)

16 rows

| Point | Corner | vdd | temperature | Pass/Fail | Gain | Bandwidth | rent Consumpt | wer Consumpti |
|---|---|---|---|---|---|---|---|---|
| 1 | nom | 950m | 27 | fail | 16.42 dB | 2.746 GHz | 942.2 uA | 895.1 uW |
| 1 | C0 | 950m | 10 | fail | 16.64 dB | 2.797 GHz | 932.1 uA | 885.5 uW |
| 1 | C1 | 950m | 45 | fail | 16.23 dB | 2.687 GHz | 950.7 uA | 903.2 uW |
| 1 | C2 | 950m | 75 | fail | 16.05 dB | 2.572 GHz | 960.1 uA | 912.1 uW |
| 2 | nom | 1 | 27 | fail | 17.07 dB | 2.74 GHz | 1.05 mA | 1.05 mW |
| 2 | C0 | 1 | 10 | fail | 17.25 dB | 2.802 GHz | 1.039 mA | 1.039 mW |
| 2 | C1 | 1 | 45 | fail | 16.91 dB | 2.67 GHz | 1.059 mA | 1.059 mW |
| 2 | C2 | 1 | 75 | fail | 16.75 dB | 2.541 GHz | 1.068 mA | 1.068 mW |
| 3 | nom | 1.05 | 27 | fail | 17.48 dB | 2.775 GHz | 1.155 mA | 1.213 mW |
| 3 | C0 | 1.05 | 10 | fail | 17.64 dB | 2.848 GHz | 1.144 mA | 1.201 mW |
| 3 | C1 | 1.05 | 45 | fail | 17.35 dB | 2.696 GHz | 1.164 mA | 1.222 mW |
| 3 | C2 | 1.05 | 75 | fail | 17.21 dB | 2.557 GHz | 1.173 mA | 1.232 mW |
| 4 | nom | 1.1 | 27 | fail | 17.66 dB | 2.856 GHz | 1.257 mA | 1.382 mW |
| 4 | C0 | 1.1 | 10 | fail | 17.79 dB | 2.94 GHz | 1.245 mA | 1.37 mW |
| 4 | C1 | 1.1 | 45 | fail | 17.55 dB | 2.77 GHz | 1.266 mA | 1.392 mW |
| 4 | C2 | 1.1 | 75 | fail | 17.4 dB | 2.627 GHz | 1.275 mA | 1.402 mW |

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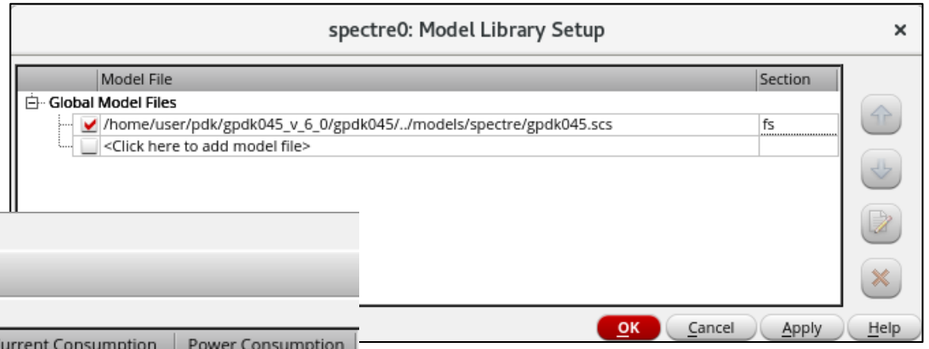
# 4. Measurements Across Sweeps and Corners *(continued)*

- Change the section to "**fs**" and run the simulation.
- The results are shown below.




Outputs Setup | Results

Detail - Transpose | Filter ...

16 rows

| Point | Corner | vdd | temperature |
|---|---|---|---|
| 1 | nom | 950m | 27 |
| 1 | C0 | 950m | 10 |
| 1 | C1 | 950m | 45 |
| 1 | C2 | 950m | 75 |
| 2 | nom | 1 | 27 |
| 2 | C0 | 1 | 10 |
| 2 | C1 | 1 | 45 |
| 2 | C2 | 1 | 75 |
| 3 | nom | 1.05 | 27 |
| 3 | C0 | 1.05 | 10 |
| 3 | C1 | 1.05 | 45 |
| 3 | C2 | 1.05 | 75 |
| 4 | nom | 1.1 | 27 |
| 4 | C0 | 1.1 | 10 |
| 4 | C1 | 1.1 | 45 |
| 4 | C2 | 1.1 | 75 |

16 rows

| Pass/Fail | Gain | Bandwidth | Current Consumption | Power Consumption |
|---|---|---|---|---|
| near | 7.42 dB | 7.541 GHz | 1.119 mA | 1.063 mW |
| near | 7.343 dB | 7.956 GHz | 1.116 mA | 1.06 mW |
| pass | 7.583 dB | 7.08 GHz | 1.121 mA | 1.065 mW |
| pass | 8.078 dB | 6.228 GHz | 1.123 mA | 1.067 mW |
| pass | 10.95 dB | 5.775 GHz | 1.259 mA | 1.259 mW |
| pass | 10.98 dB | 6.088 GHz | 1.257 mA | 1.257 mW |
| pass | 10.95 dB | 5.509 GHz | 1.261 mA | 1.261 mW |
| pass | 11.05 dB | 5.085 GHz | 1.26 mA | 1.26 mW |
| pass | 12.54 dB | 5.343 GHz | 1.398 mA | 1.468 mW |
| pass | 12.62 dB | 5.569 GHz | 1.397 mA | 1.467 mW |
| pass | 12.48 dB | 5.119 GHz | 1.398 mA | 1.468 mW |
| pass | 12.44 dB | 4.764 GHz | 1.396 mA | 1.466 mW |
| pass | 13.59 dB | 5.129 GHz | 1.536 mA | 1.69 mW |
| pass | 13.69 dB | 5.345 GHz | 1.536 mA | 1.69 mW |
| pass | 13.51 dB | 4.913 GHz | 1.535 mA | 1.689 mW |
| pass | 13.46 dB | 4.568 GHz | 1.531 mA | 1.685 mW |

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# 4. Measurements Across Sweeps and Corners *(continued)*

- Change the section to "**sf**" and run the simulation.
- In this case, the bandwidth fails for all the design points.
- The gain, current, and power consumption pass the given spec for all the design points.
- The results are shown below.

Outputs Setup | Results

Detail - Transpose | Filter ...

16 rows

| Point | Corner | vdd | temperature | Pass/Fail | Gain | Bandwidth | Current Consumption | Power Consumption |
|---|---|---|---|---|---|---|---|---|
| Filter | Filter | Filter | Filter | Filter | Filter | Filter | Filter | Filter |
| 1 | nom | 950m | 27 | fail | 15.6 dB | 3.425 GHz | 1.146 mA | 1.089 mW |
| 1 | C0 | 950m | 10 | fail | 15.8 dB | 3.513 GHz | 1.14 mA | 1.083 mW |
| 1 | C1 | 950m | 45 | fail | 15.43 dB | 3.33 GHz | 1.151 mA | 1.093 mW |
| 1 | C2 | 950m | 75 | fail | 15.26 dB | 3.165 GHz | 1.154 mA | 1.096 mW |
| 2 | nom | 1 | 27 | fail | 16.22 dB | 3.404 GHz | 1.261 mA | 1.261 mW |
| 2 | C0 | 1 | 10 | fail | 16.42 dB | 3.497 GHz | 1.256 mA | 1.256 mW |
| 2 | C1 | 1 | 45 | fail | 16.06 dB | 3.305 GHz | 1.266 mA | 1.266 mW |
| 2 | C2 | 1 | 75 | fail | 15.89 dB | 3.136 GHz | 1.268 mA | 1.268 mW |
| 3 | nom | 1.05 | 27 | fail | 16.69 dB | 3.412 GHz | 1.375 mA | 1.443 mW |
| 3 | C0 | 1.05 | 10 | fail | 16.88 dB | 3.51 GHz | 1.369 mA | 1.438 mW |
| 3 | C1 | 1.05 | 45 | fail | 16.53 dB | 3.309 GHz | 1.378 mA | 1.447 mW |
| 3 | C2 | 1.05 | 75 | fail | 16.36 dB | 3.138 GHz | 1.38 mA | 1.449 mW |
| 4 | nom | 1.1 | 27 | fail | 17 dB | 3.453 GHz | 1.485 mA | 1.634 mW |
| 4 | C0 | 1.1 | 10 | fail | 17.19 dB | 3.555 GHz | 1.48 mA | 1.628 mW |
| 4 | C1 | 1.1 | 45 | fail | 16.84 dB | 3.348 GHz | 1.489 mA | 1.637 mW |
| 4 | C2 | 1.1 | 75 | fail | 16.65 dB | 3.177 GHz | 1.489 mA | 1.638 mW |




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# 5. Monte Carlo Statistical Analysis

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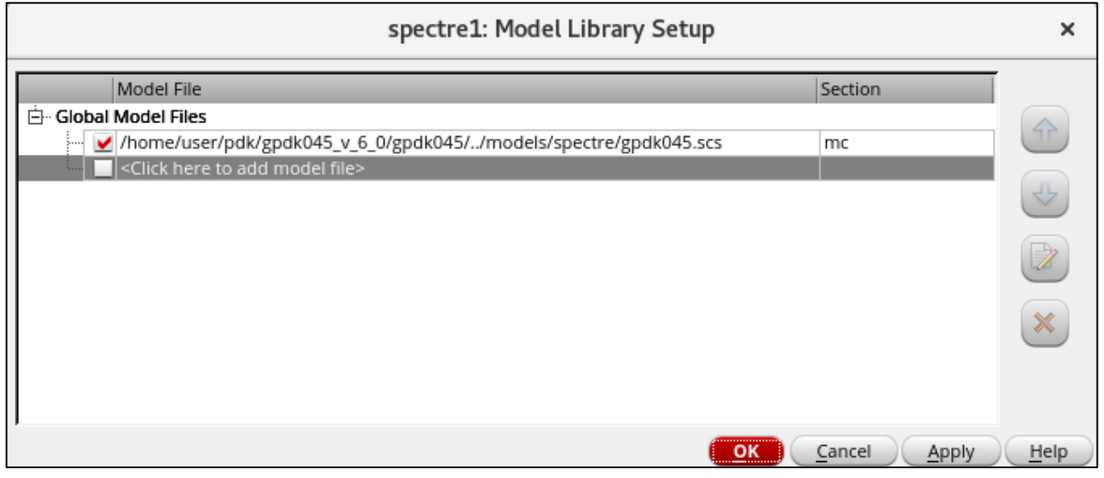
# 5. Monte Carlo Statistical Analysis

- Change the section to “**mc**”.







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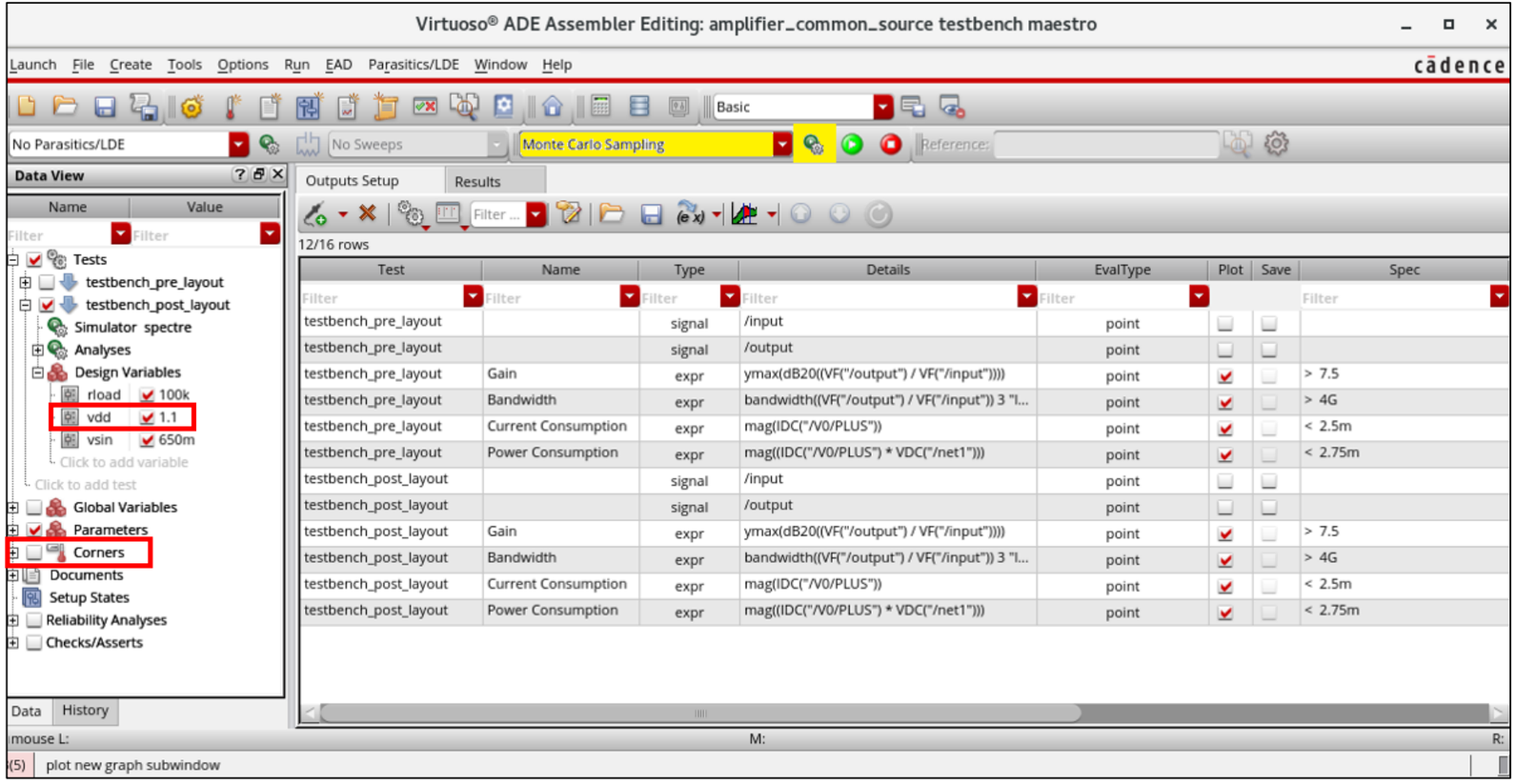
# 5. Monte Carlo Statistical Analysis

- To run the Monte Carlo Analysis, remove the sweep, uncheck Corners, and choose Monte Carlo Sampling from the drop-down list.







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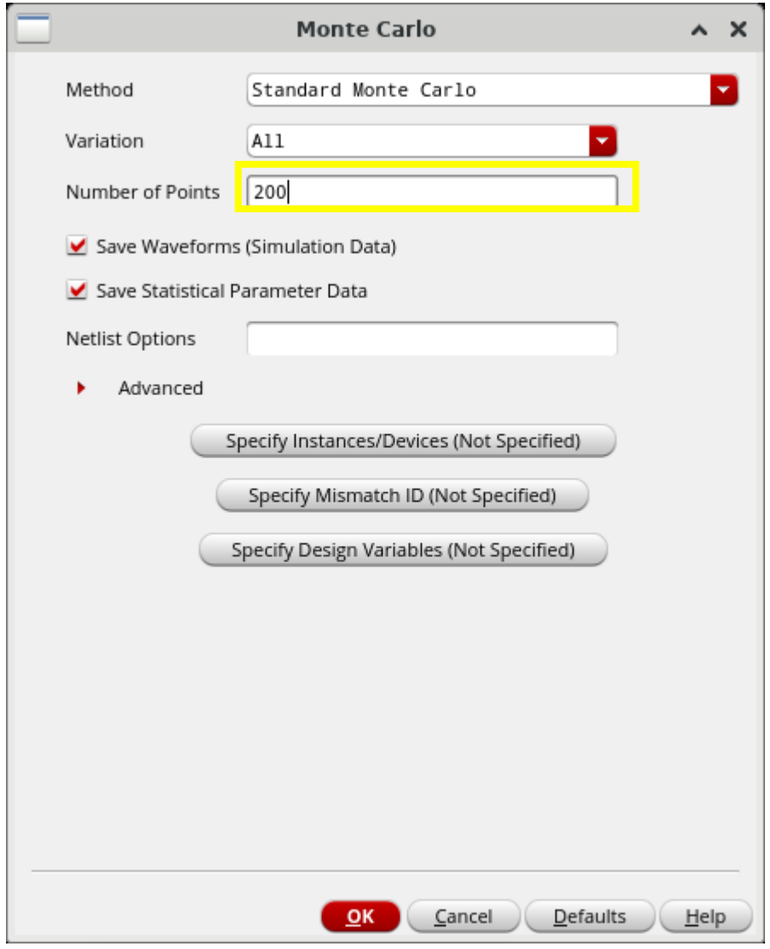
# 5. Monte Carlo Statistical Analysis *(continued)*

- Click on the Simulation Options button  and change the field “Run a fixed number of points” to 200.
- Run the simulation.







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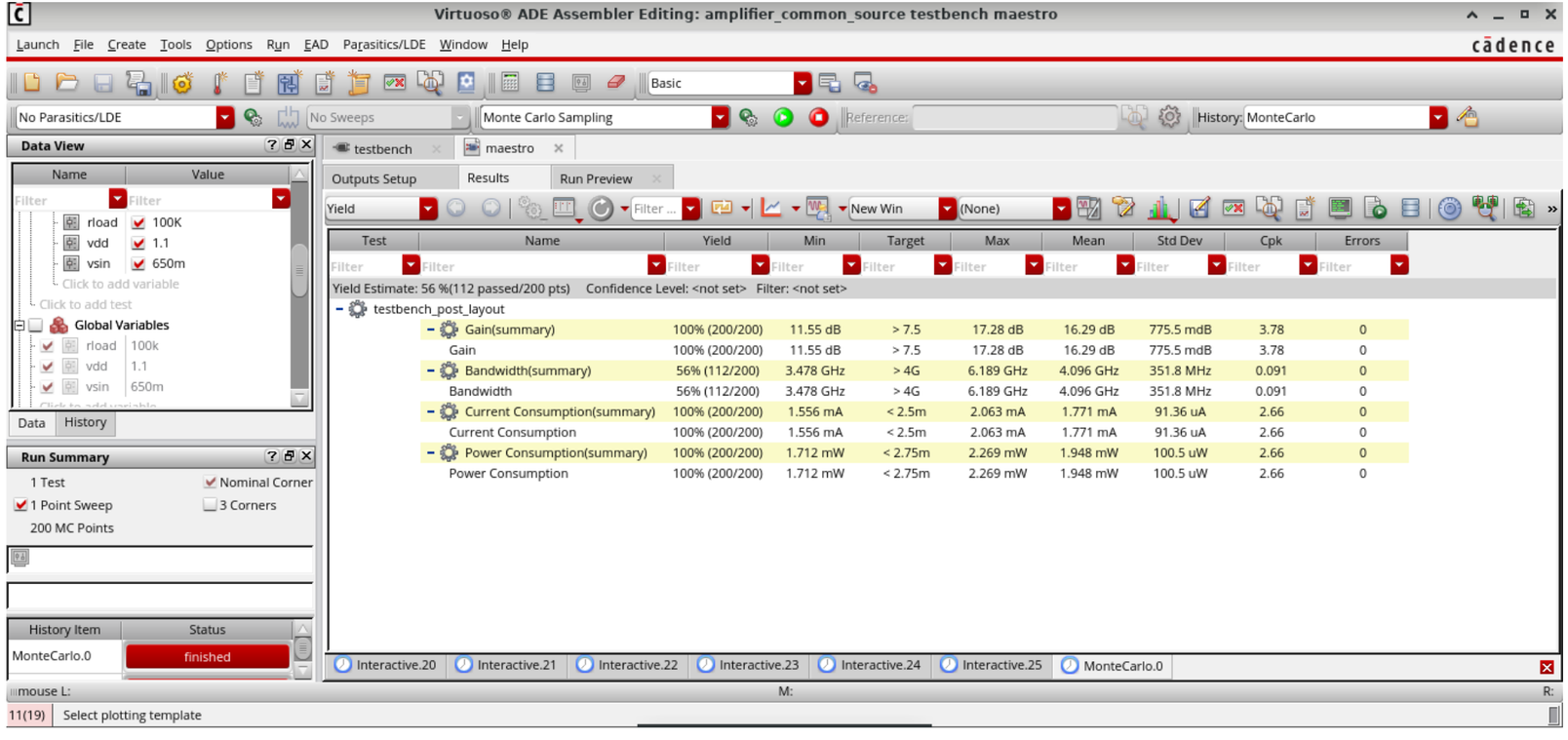
# 5. Monte Carlo Statistical Analysis *(continued)*

- The results are displayed using the “Yield” format, as shown below.



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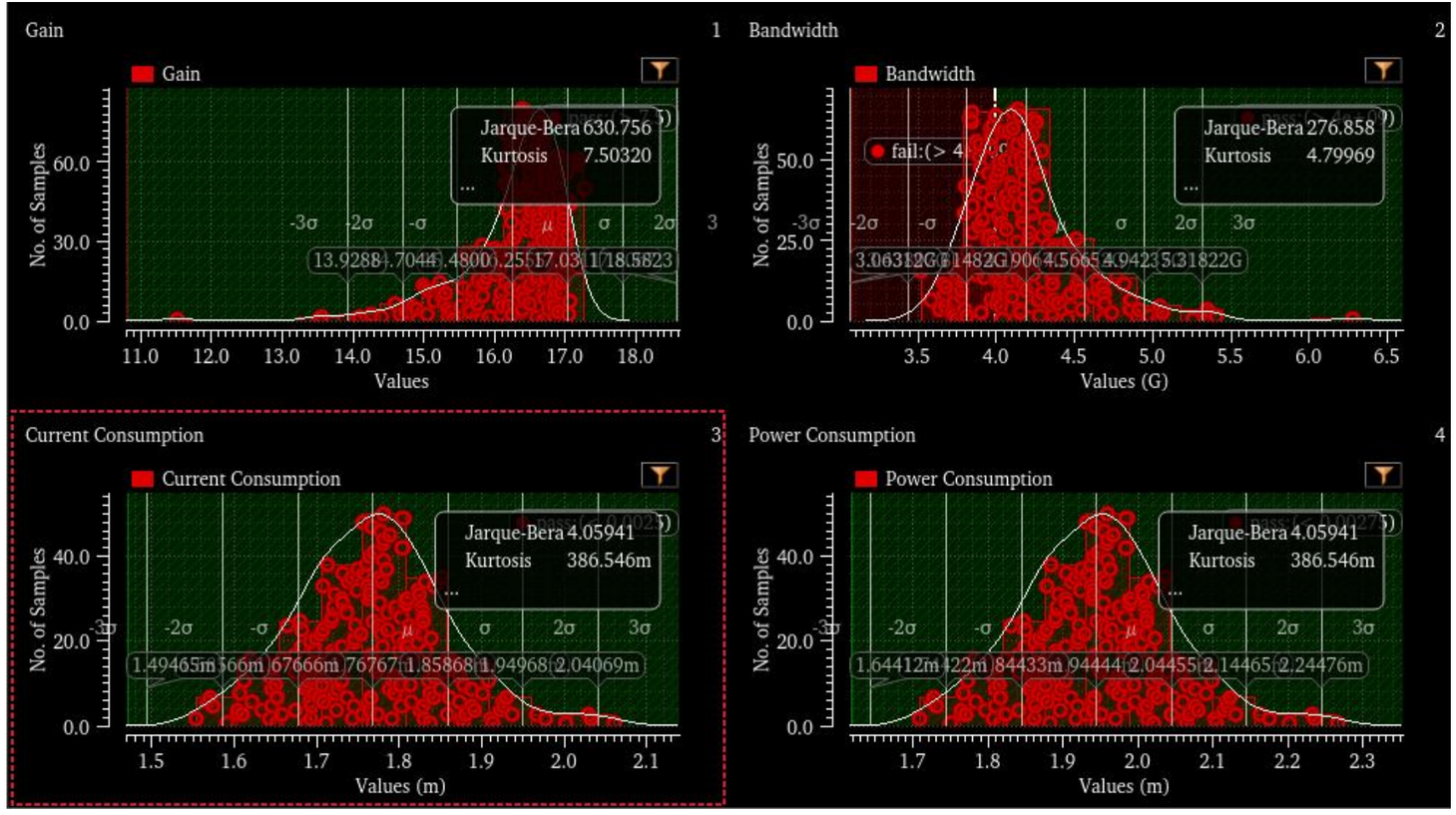
# 5. Monte Carlo Statistical Analysis *(continued)*

- Click on the icon and select Plot All.
- The histograms plotted are shown below.





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