Virtuoso 23.1
Module 6 – Measurements Across Corners Using ADE Assembler

American University of Beirut (AUB)
Lebanon

AMERICAN UNIVERSITY OF BEIRUT

Contents

cadence

Module Objective

In this module, we will learn how to:

- add an additional testbench in ADE Assembler
- set up local and global variables
- run analyses across corners
- run Monte Carlo analysis using ADE Assembler

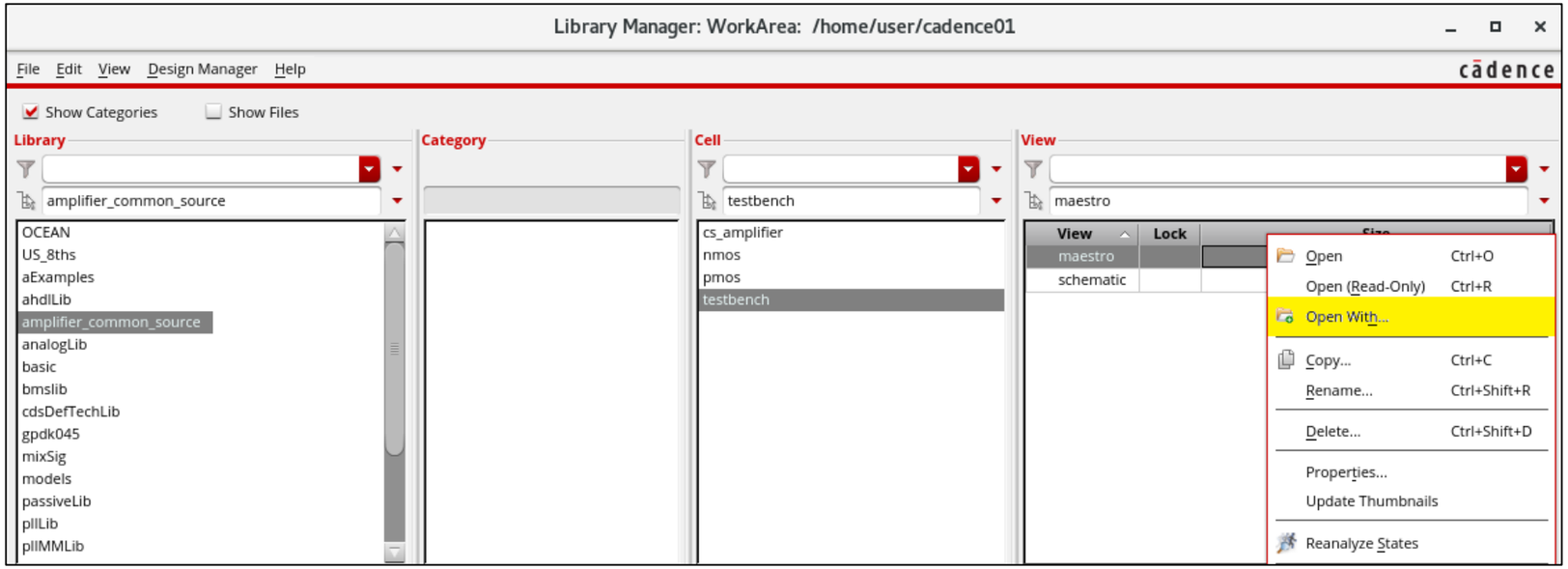
1. Migrating from ADE Explorer to ADE Assembler

AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- Monte Carlo Analysis

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

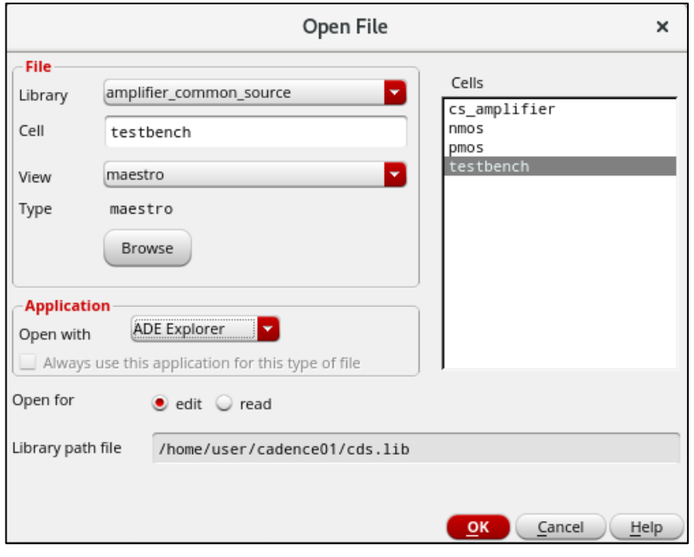
- Before starting, we must change the section in the Model Library from **mc** to **tt**.
- To do that, We should first head over to ADE Explorer and select the Model Library settings.
- Go to “Library Manager”, select the Library “amplifier_common_source”, the Cell “testbench” and the “maestro” view, then right click and select **Open With**.



cadence

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

- The “Open File” form opens, select “**ADE Explorer**” from the drop-down list as the application.



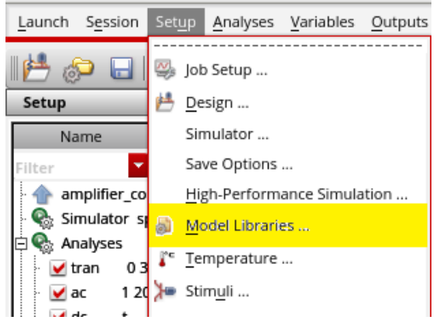
cadence

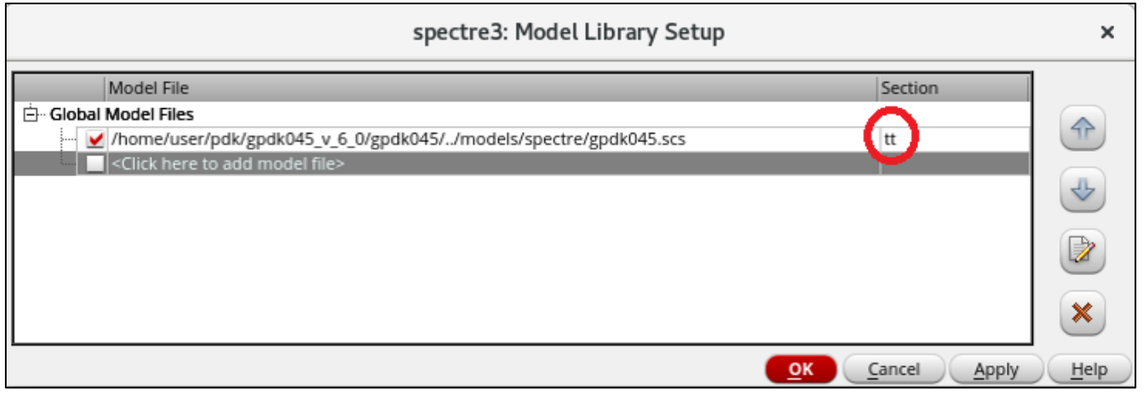
AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- Monte Carlo Analysis

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

- The process condition (section) used for the simulations is “mc”. It should be changed to “tt”.
- From Setup → Model Libraries, change the section to “tt”.





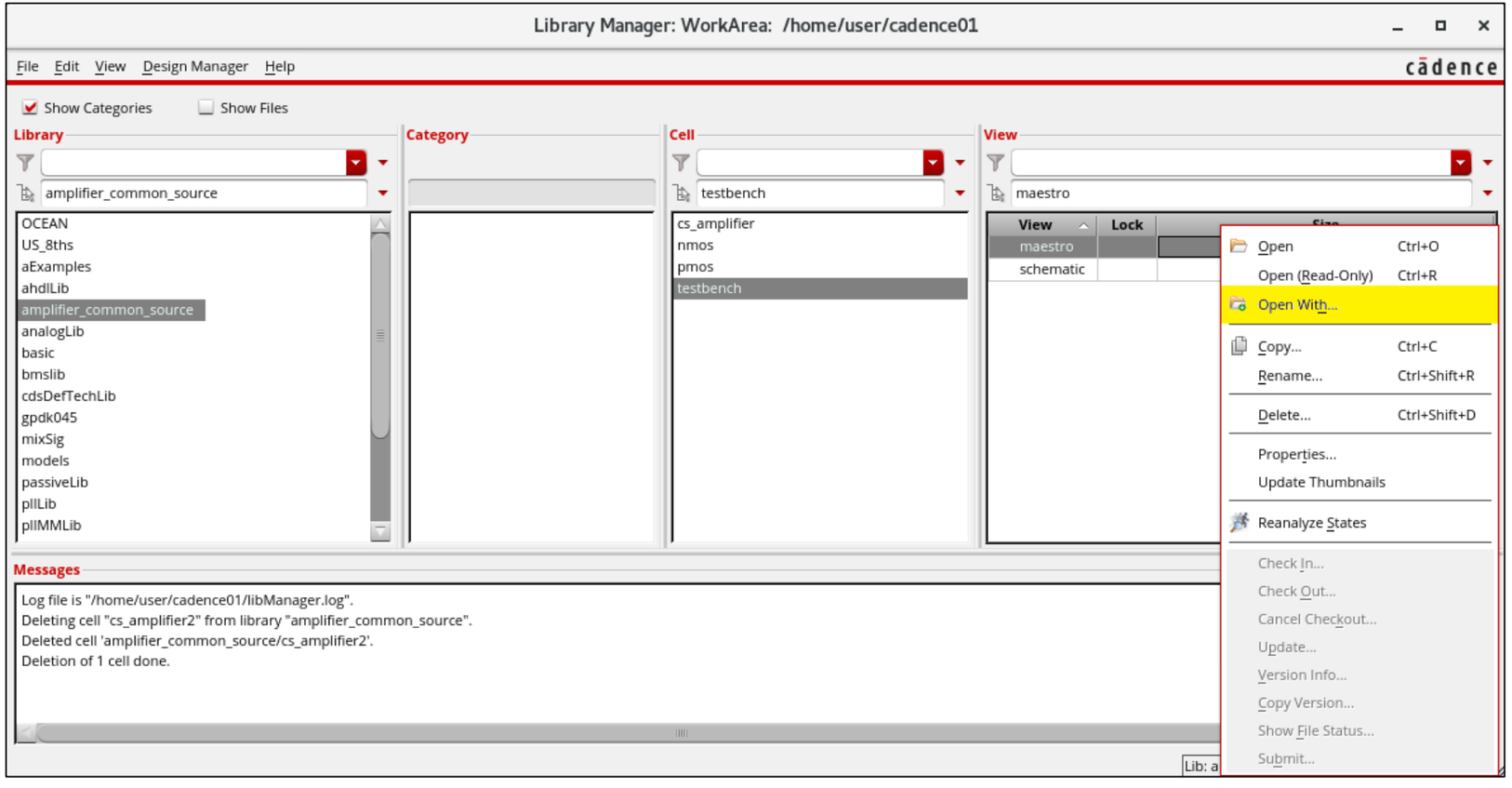
cadence

AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- Monte Carlo Analysis

1. Migrating from ADE Explorer to ADE Assembler

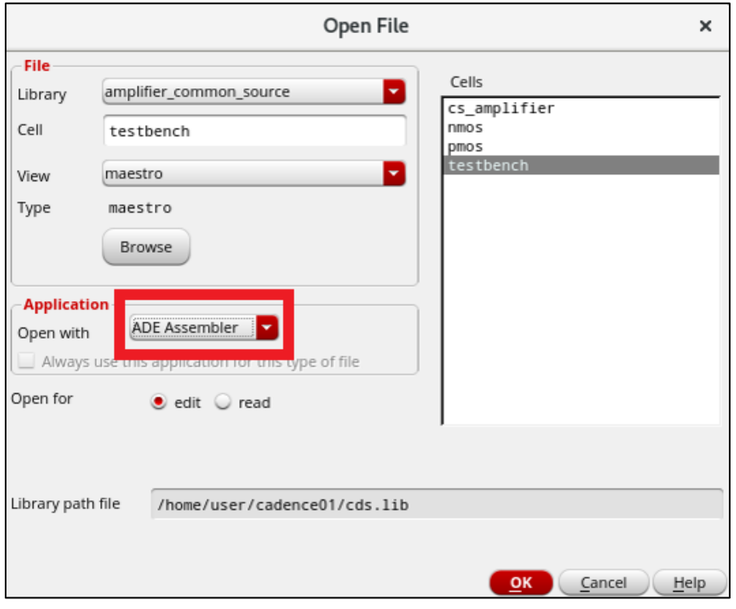
- Go back to the “Library Manager”, select the Library “amplifier_common_source”, the Cell “testbench” and the “maestro” view, then right click and select **Open With**.



cadence

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

- The “Open File” form opens, and this time select **ADE Assembler** instead of ADE Explorer from the drop-down list as the application.



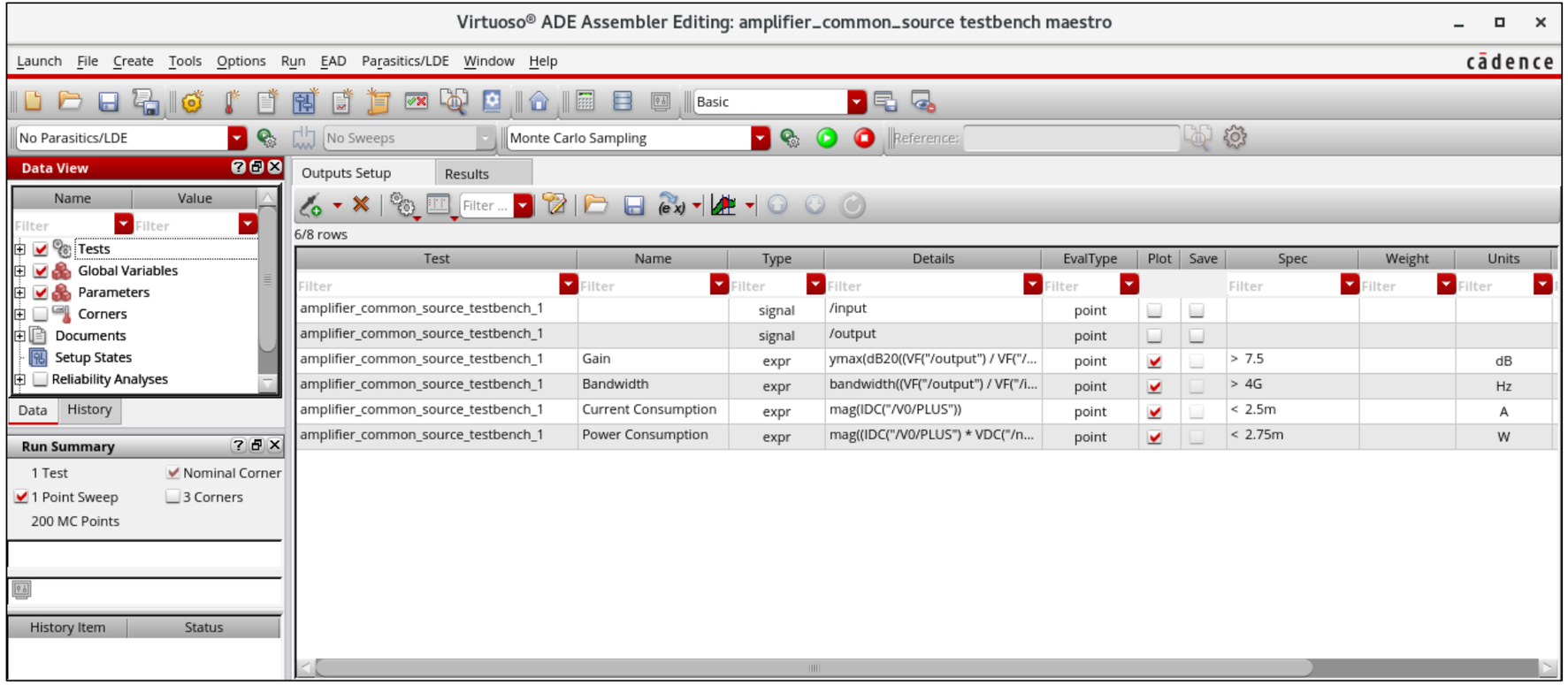
cadence

AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- Monte Carlo Analysis

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

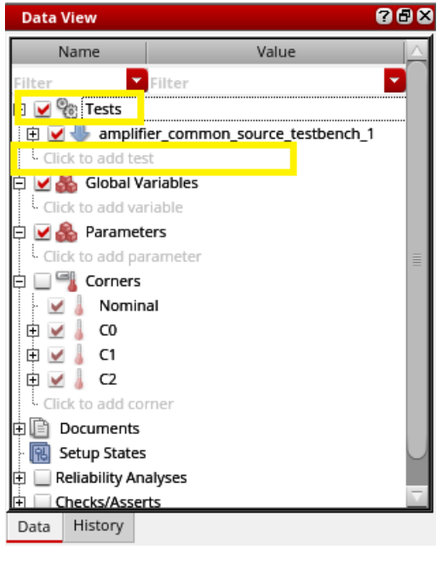
- The ADE Assembler window opens, this is the environment where we will run our simulations.
- You can notice the similarity between ADE Explorer and ADE Assembler.

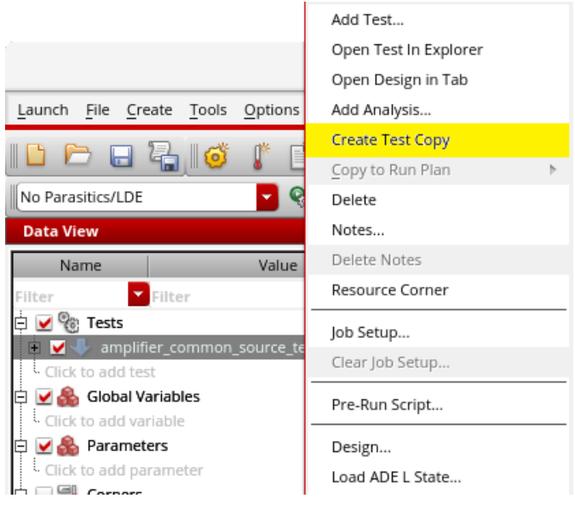


cadence

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

- Explorer defines a single testbench setup. However, Assembler supports multiple testbench setups.
- In each testbench configuration, it is possible to define analyses (tran, dc, ac), variables, parameters, model libraries, etc.
- In this example, we will have two test benches.
- To add a test bench, expand “Tests” and “Click to add test” then choose the test bench you want to add.
- In our case, we are going to copy our original test bench and do some modifications on it.
- To do so, right click on your test bench and click on Create Test Copy.



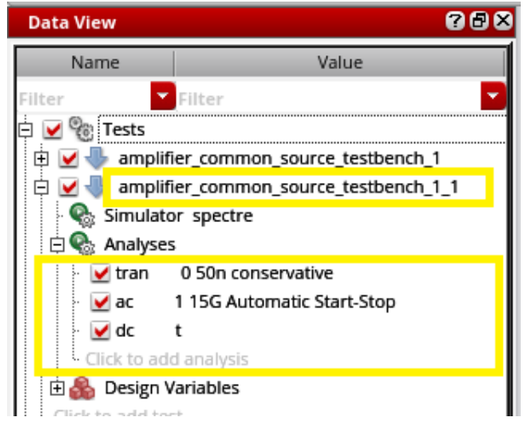


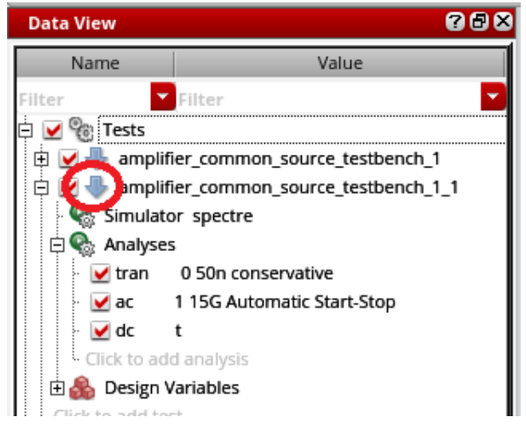
cadence

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

- Expand the second testbench, then expand “Analyses” and click on “Click to add analysis”. The form “Choosing Analyses” opens, change the stop time of **tran** to **50ns**, the frequency sweep of **ac** to **1 - 15G** and keep the dc part as it is. The analyses section should now look as in the figure.

- To switch from ADE Assembler to ADE Explorer, under the **Data View** Assistant in the ADE Assembler window, click on the **arrow** of the test that you want to switch to ADE Explorer.

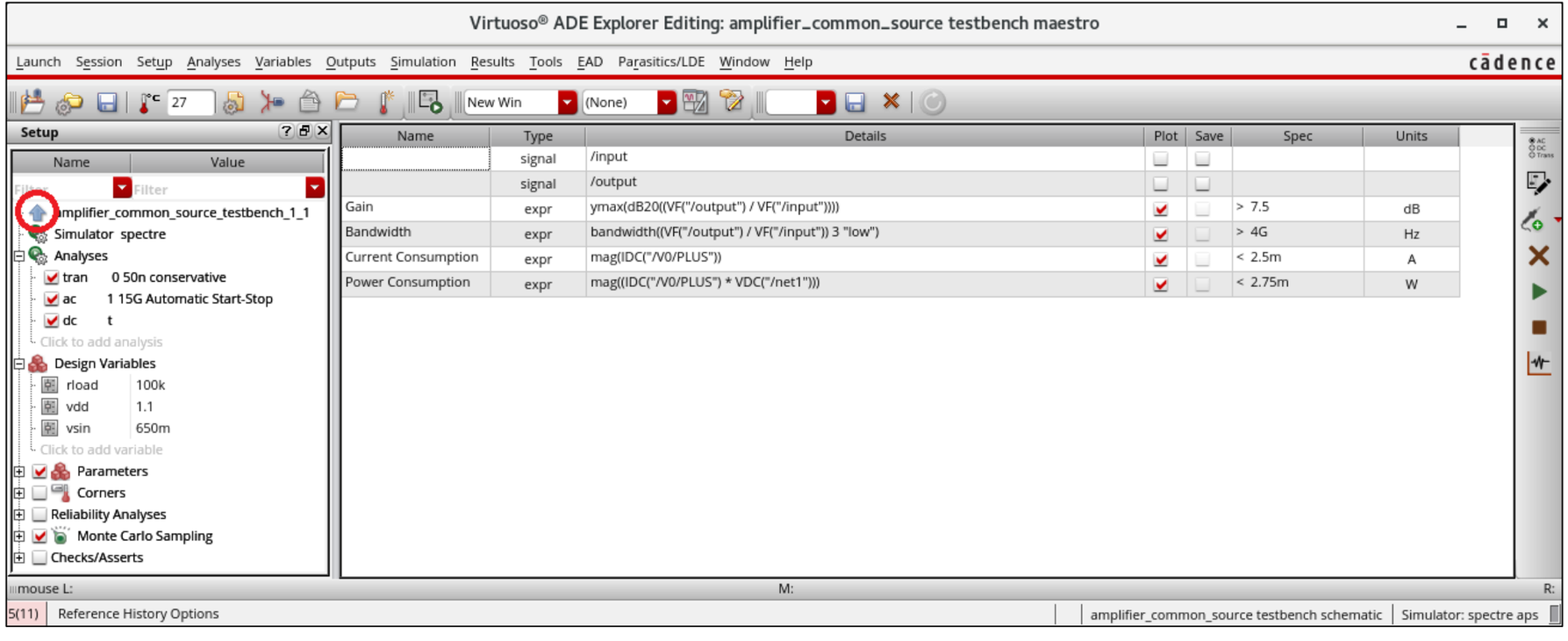




cadence

1. Migrating from ADE Explorer to ADE Assembler *(continued)*

- The test opens in ADE Explorer after clicking on the arrow.
- If you want to go back to **ADE Assembler**, click on the **arrow** again, so it points downwards.



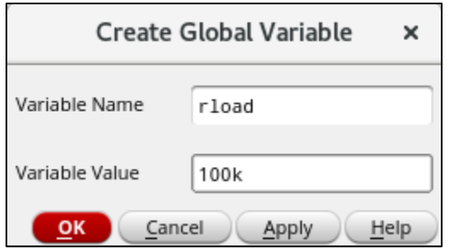
- Note if the Units column is not visible, right click on “Spec” and enable the Units column.

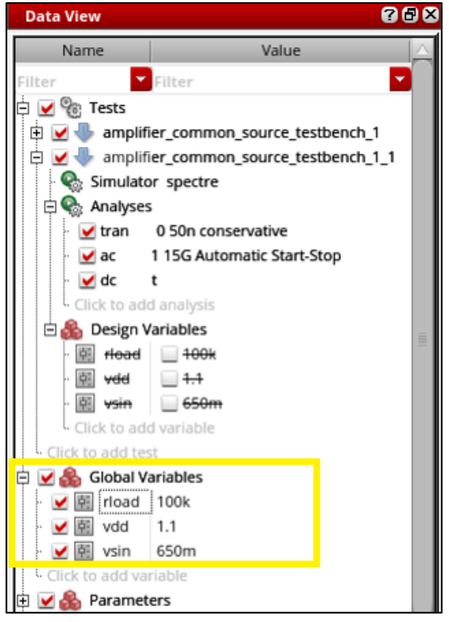
cadence

2. Sweeping Variables for each Testbench

2. Sweeping Variables for each Testbench

- In **ADE Assembler**, Variables can be found under **Data View** Assistant, however since it is a multiple test bench setup, two types of Variables exist:
  - Local Variables
  - Global Variables
- Local Variables are variables associated with a particular test, while Global Variables are variables defined for all tests.
- If Global Variables are selected, Local Variables are marked with a strikethrough since they are overwritten by Global Variable values.
- To add global variables, click on "**Click to add variable**" in the "Global Variables" section. The window "Create Global Variables" opens, add the variables with their values as shown in the figure.

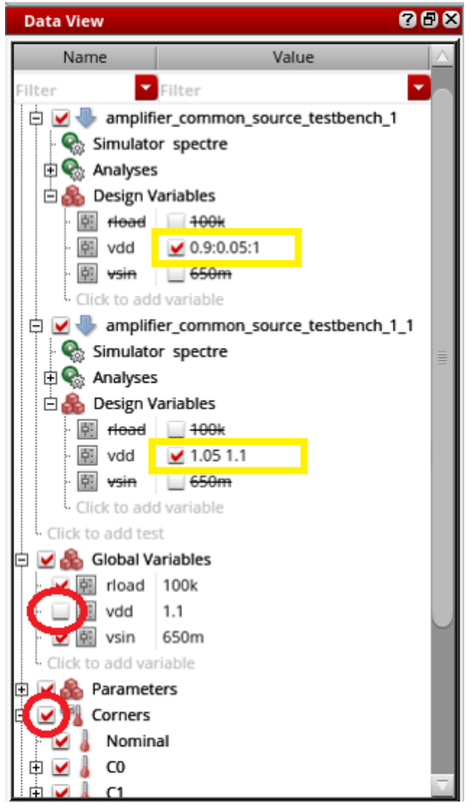




cadence

2. Sweeping Variables for each Testbench *(continued)*

- Beside being able to sweep Global Variables, it is also possible to sweep Local Variables in ADE Assembler.
- In **Data View** Assistant, expand both tests, then expand the **Design Variables** section.
- Make sure to uncheck the checkbox of “vdd” under Global Variables, and to check the checkbox under the Local Variables.
- Enter the values of “vdd” in each test as shown:
  - `0.9:0.05:1`, for the first test
  - `1.05 1.1`, for the second
- Check the checkbox of Corners.
- Now you have set a three point voltage sweep for the first test, and a two point voltage sweep for the second test.



cadence

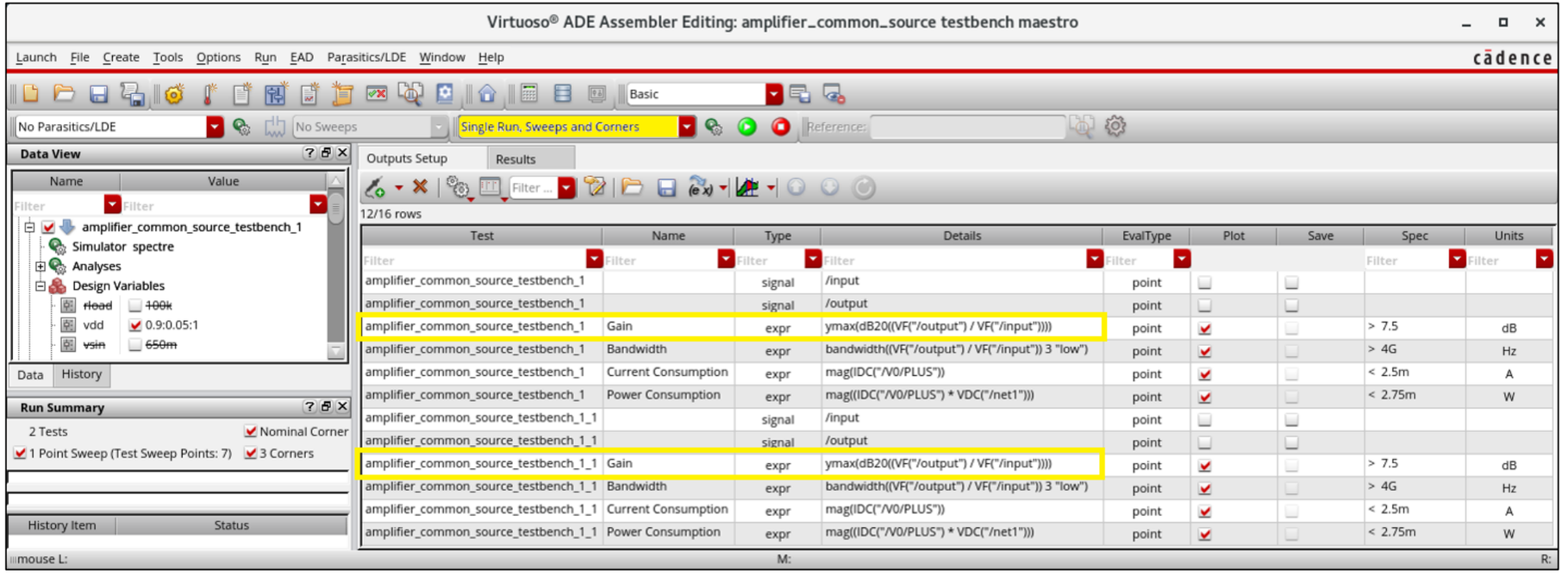
3. Measurement Across Sweeps and Corners

AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- **Measurements Across Sweeps and Corners**
- Monte Carlo Analysis

3. Measurement Across Sweeps and Corners

- Measurements enable processing of the output results across Corners and Sweeps.
- The functions that can be used to process data are average, ymax, ymin, peakToPeak, stddev.
- The function that contains ymax is the gain in our case.
- Modify the run mode to "**Single Run, Sweeps and Corners**", then click on the green **Run Simulation** icon.



- Note if the Units column is not visible, right click on "Spec" and enable the Units column.

cadence

AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- **Measurements Across Sweeps and Corners**
- Monte Carlo Analysis

3. Measurement Across Sweeps and Corners *(continued)*

- Notice that all the outputs are calculated for each sweep point.

Outputs Setup | Results

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

	Parameter	Nominal	C0	C1	C2
	temperature	27	10	45	75

30/80 rows

Point	Test	Output	Nominal	Spec	Weight	Pass/Fail	Min	Max	C0	C1	C2
Parameters: vdd=900m											
1	amplifier_comm...	Gain	13.34 dB	> 7.5		pass	13.02 dB	13.52 dB	13.52 dB	13.18 dB	13.02 dB
1	amplifier_comm...	Bandwidth	6.556 GHz	> 4G		pass	5.896 GHz	6.802 GHz	6.802 GHz	6.305 GHz	5.896 GHz
1	amplifier_comm...	Current Consu...	1.208 mA	< 2.5m		pass	1.206 mA	1.209 mA	1.206 mA	1.209 mA	1.207 mA
1	amplifier_comm...	Power Consum...	1.087 mW	< 2.75m		pass	1.085 mW	1.088 mW	1.085 mW	1.088 mW	1.087 mW
1	amplifier_comm...	/input									
1	amplifier_comm...	/output									
Parameters: vdd=950m											
2	amplifier_comm...	Gain	14.37 dB	> 7.5		pass	14.06 dB	14.55 dB	14.55 dB	14.22 dB	14.06 dB
2	amplifier_comm...	Bandwidth	6.385 GHz	> 4G		pass	5.709 GHz	6.634 GHz	6.634 GHz	6.129 GHz	5.709 GHz
2	amplifier_comm...	Current Consu...	1.364 mA	< 2.5m		pass	1.36 mA	1.364 mA	1.362 mA	1.364 mA	1.36 mA
2	amplifier_comm...	Power Consum...	1.296 mW	< 2.75m		pass	1.292 mW	1.296 mW	1.294 mW	1.296 mW	1.292 mW
2	amplifier_comm...	/input									
2	amplifier_comm...	/output									
Parameters: vdd=1											
3	amplifier_comm...	Gain	15.26 dB	> 7.5		pass	14.95 dB	15.45 dB	15.45 dB	15.11 dB	14.95 dB
3	amplifier_comm...	Bandwidth	6.229 GHz	> 4G		pass	5.543 GHz	6.48 GHz	6.48 GHz	5.97 GHz	5.543 GHz
3	amplifier_comm...	Current Consu...	1.518 mA	< 2.5m		pass	1.51 mA	1.518 mA	1.518 mA	1.517 mA	1.51 mA
3	amplifier_comm...	Power Consum...	1.518 mW	< 2.75m		pass	1.51 mW	1.518 mW	1.518 mW	1.517 mW	1.51 mW
3	amplifier_comm...	/input									
3	amplifier_comm...	/output									
Parameters: vdd=1.05											
4	amplifier_comm...	Gain	16.02 dB	> 7.5		pass	15.69 dB	16.21 dB	16.21 dB	15.86 dB	15.69 dB
4	amplifier_comm...	Bandwidth	6.028 GHz	> 4G		pass	5.374 GHz	6.325 GHz	6.325 GHz	5.753 GHz	5.374 GHz
4	amplifier_comm...	Current Consu...	1.671 mA	< 2.5m		pass	1.658 mA	1.672 mA	1.672 mA	1.667 mA	1.658 mA
4	amplifier_comm...	Power Consum...	1.754 mW	< 2.75m		pass	1.741 mW	1.755 mW	1.755 mW	1.751 mW	1.741 mW
4	amplifier_comm...	/input									

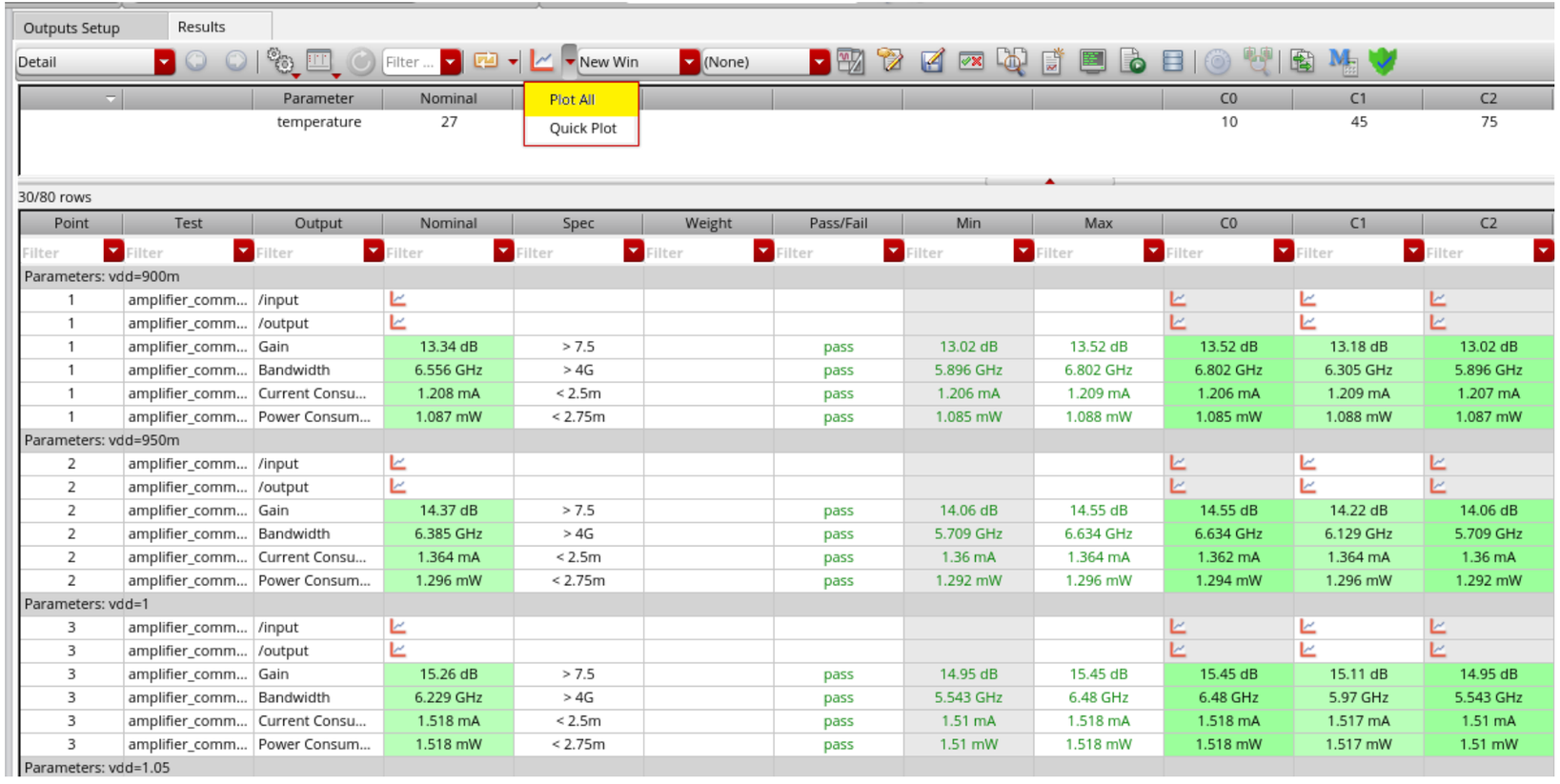
cadence

AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- **Measurements Across Sweeps and Corners**
- Monte Carlo Analysis

3. Measurement Across Sweeps and Corners *(continued)*

- It is possible to plot your results across Corners and Design points.
- Click on the arrow and select plot all.



Point	Test	Output	Nominal	Spec	Weight	Pass/Fail	Min	Max	C0	C1	C2
Parameters: vdd=900m											
1	amplifier_comm...	/input									
1	amplifier_comm...	/output									
1	amplifier_comm...	Gain	13.34 dB	> 7.5		pass	13.02 dB	13.52 dB	13.52 dB	13.18 dB	13.02 dB
1	amplifier_comm...	Bandwidth	6.556 GHz	> 4G		pass	5.896 GHz	6.802 GHz	6.802 GHz	6.305 GHz	5.896 GHz
1	amplifier_comm...	Current Consu...	1.208 mA	< 2.5m		pass	1.206 mA	1.209 mA	1.206 mA	1.209 mA	1.207 mA
1	amplifier_comm...	Power Consum...	1.087 mW	< 2.75m		pass	1.085 mW	1.088 mW	1.085 mW	1.088 mW	1.087 mW
Parameters: vdd=950m											
2	amplifier_comm...	/input									
2	amplifier_comm...	/output									
2	amplifier_comm...	Gain	14.37 dB	> 7.5		pass	14.06 dB	14.55 dB	14.55 dB	14.22 dB	14.06 dB
2	amplifier_comm...	Bandwidth	6.385 GHz	> 4G		pass	5.709 GHz	6.634 GHz	6.634 GHz	6.129 GHz	5.709 GHz
2	amplifier_comm...	Current Consu...	1.364 mA	< 2.5m		pass	1.36 mA	1.364 mA	1.362 mA	1.364 mA	1.36 mA
2	amplifier_comm...	Power Consum...	1.296 mW	< 2.75m		pass	1.292 mW	1.296 mW	1.294 mW	1.296 mW	1.292 mW
Parameters: vdd=1											
3	amplifier_comm...	/input									
3	amplifier_comm...	/output									
3	amplifier_comm...	Gain	15.26 dB	> 7.5		pass	14.95 dB	15.45 dB	15.45 dB	15.11 dB	14.95 dB
3	amplifier_comm...	Bandwidth	6.229 GHz	> 4G		pass	5.543 GHz	6.48 GHz	6.48 GHz	5.97 GHz	5.543 GHz
3	amplifier_comm...	Current Consu...	1.518 mA	< 2.5m		pass	1.51 mA	1.518 mA	1.518 mA	1.517 mA	1.51 mA
3	amplifier_comm...	Power Consum...	1.518 mW	< 2.75m		pass	1.51 mW	1.518 mW	1.518 mW	1.517 mW	1.51 mW
Parameters: vdd=1.05											

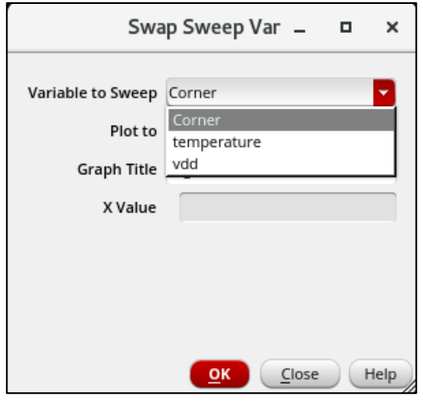
cadence

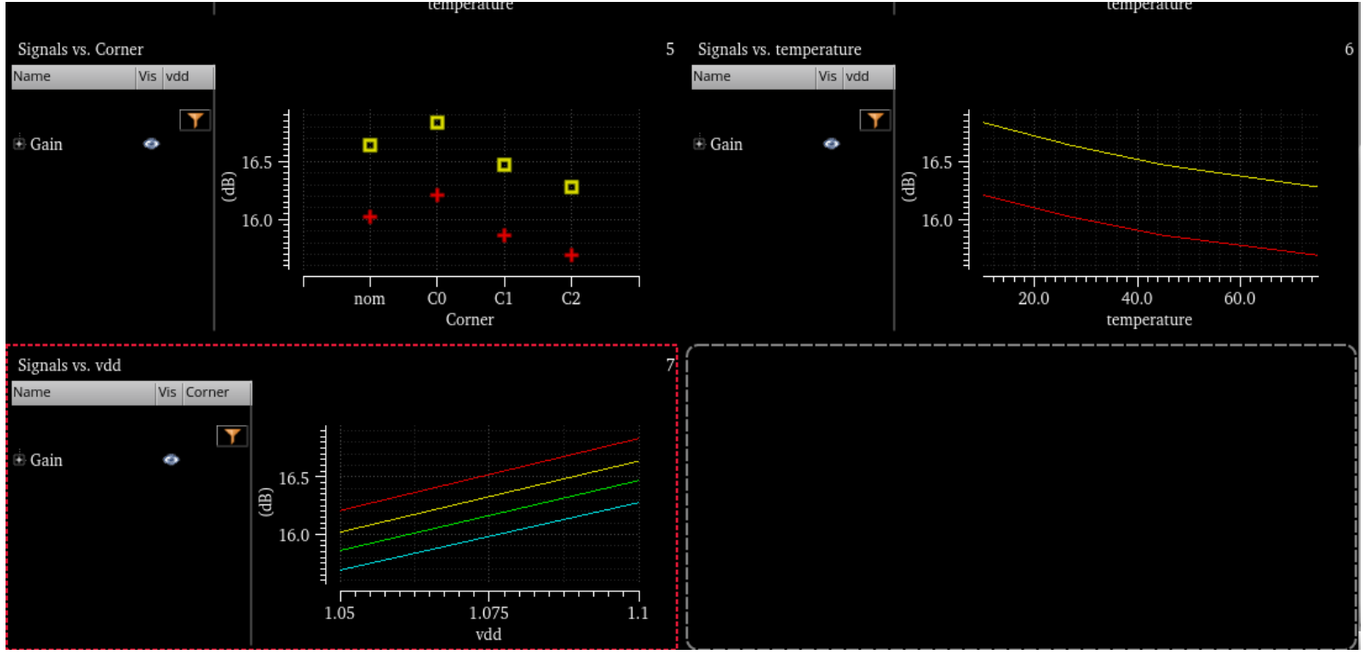
AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- **Measurements Across Sweeps and Corners**
- Monte Carlo Analysis

3. Measurement Across Sweeps and Corners *(continued)*

- We can change the x-axis to Temperature, Corner, or to a design variable that is swept (in this case vdd).
- In the VIVA XL window, right click on the x-axis of an output, select “Swap Sweep Var”. Expand the drop-down list to choose the desired x-axis. Below are the plots of the Gain across all the Sweep Variables (temperature, corner, and vdd).





cadence

4. Monte Carlo Analysis

AMERICAN UNIVERSITY OF BEIRUT

Migrating from ADE Explorer to ADE Assembler

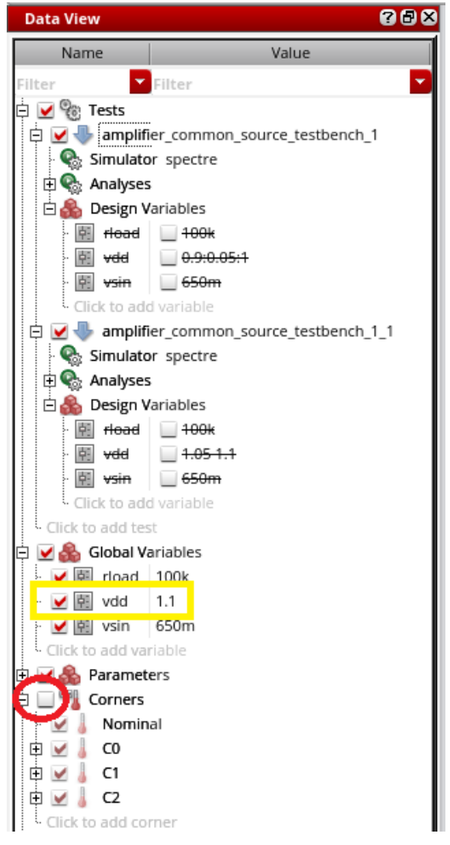
Sweeping Variables for each Testbench

Measurements Across Sweeps and Corners

Monte Carlo Analysis

4. Monte Carlo Analysis

- It is also possible to run Monte Carlo analysis with ADE Assembler.
- Under the **Data View** Assistant:
  - Check the “vdd” variable under **Global Variables** to overwrite the local variable sweeps defined earlier.
  - Uncheck the **Corners.**



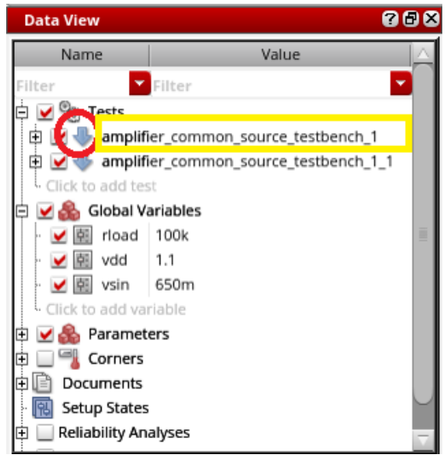
cadence

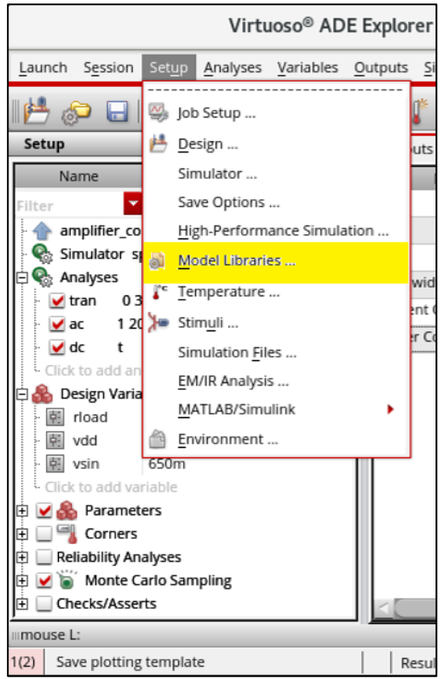
AMERICAN UNIVERSITY OF BEIRUT

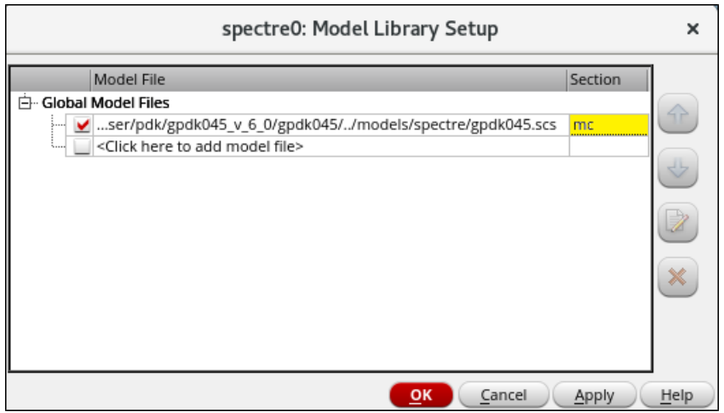
- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- **Monte Carlo Analysis**

4. Monte Carlo Analysis

- To run Monte Carlo Analysis, it is important to switch from **tt** to **mc** in the Model Library's section in each test in the Assembler.
- Start with the "amplifier_common_source_testbench_1" test and press on the blue arrow to switch to ADE Explorer.
- From Setup → Model Libraries, change the section to "mc", then press **OK**.







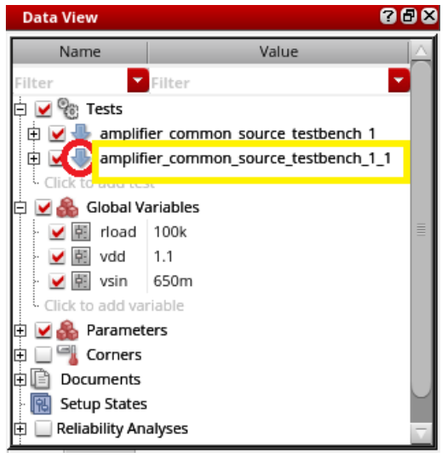
cadence

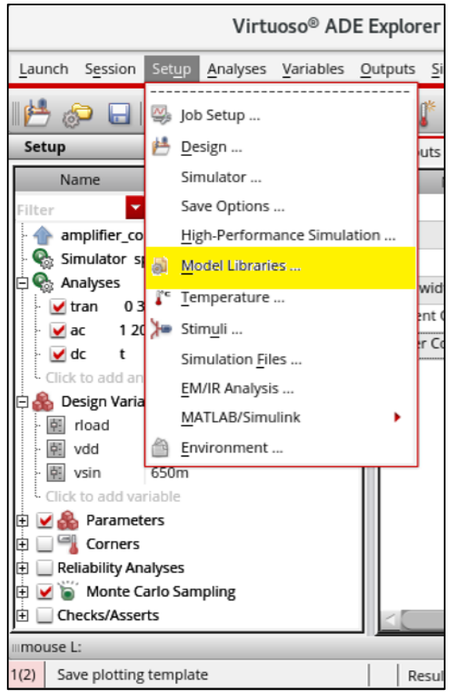
AMERICAN UNIVERSITY OF BEIRUT

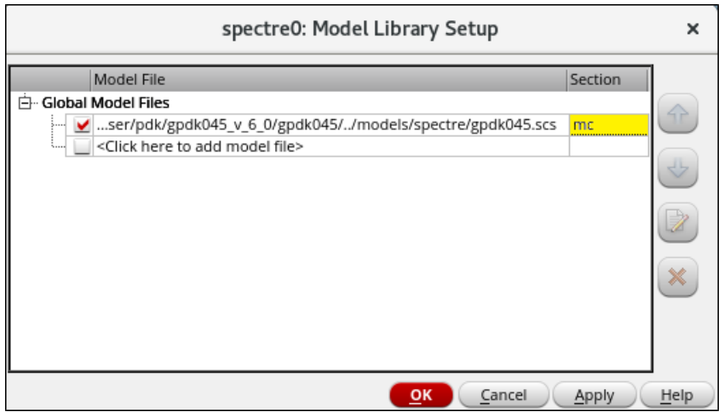
- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- Monte Carlo Analysis

4. Monte Carlo Analysis

- Head back to ADE Assembler by pressing on the blue arrow.
- Repeat the same process for the “amplifier_common_source_testbench_1_1” test.
- Press on the blue arrow to return to ADE Assembler.



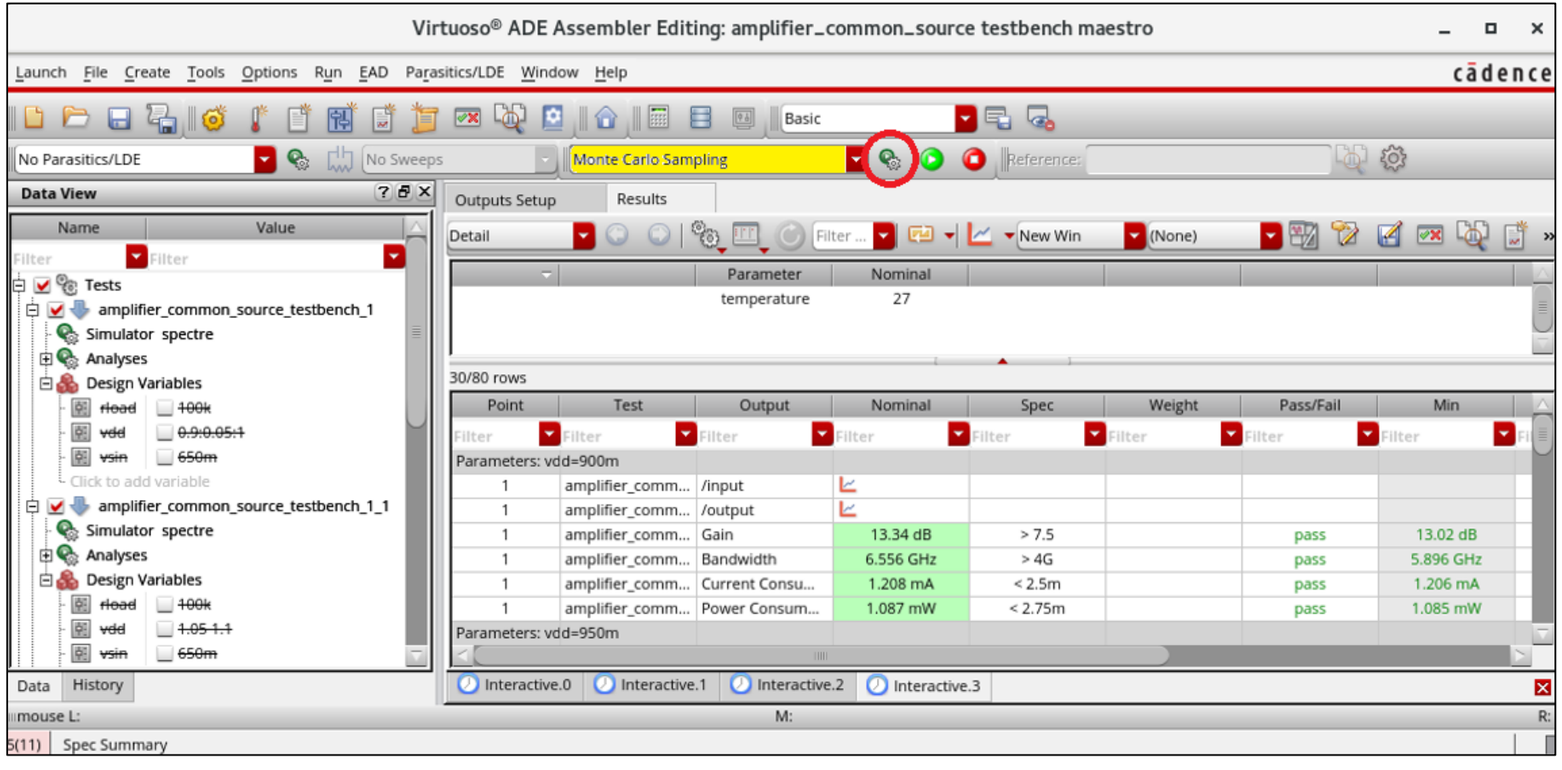




cadence

4. Monte Carlo Analysis *(continued)*

- Modify the run mode to "**Monte Carlo Sampling**", then click on the **Simulation Options** icon.

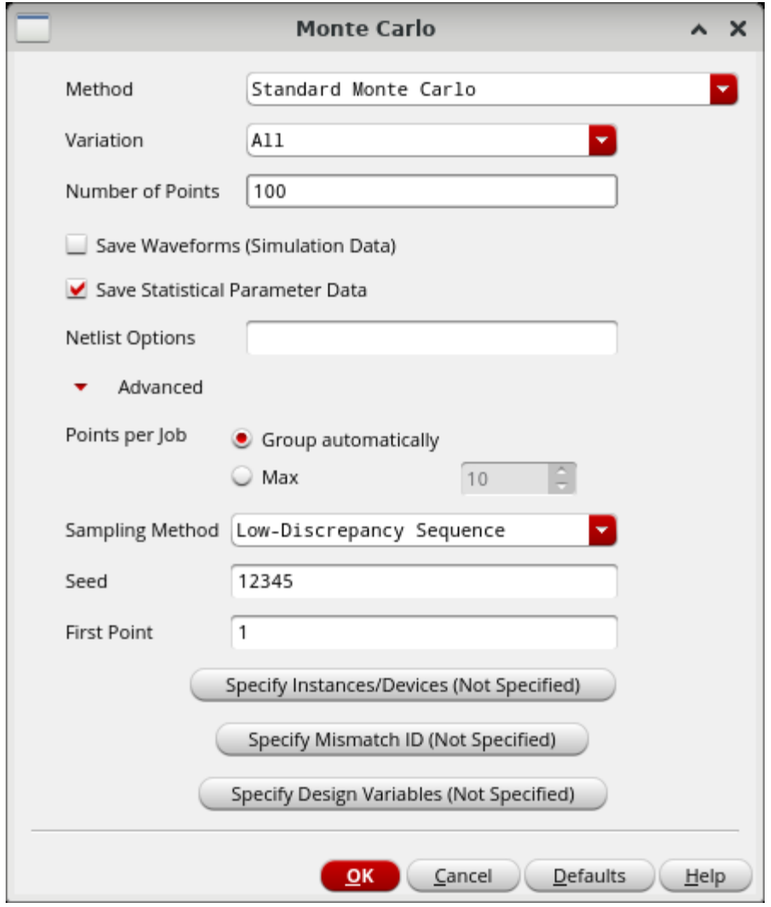


AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- Monte Carlo Analysis

4. Monte Carlo Analysis *(continued)*

- Change the number of points to “100” and click on **OK** to save your **Simulation Options**.
- Click on the green **Run Simulation** icon.



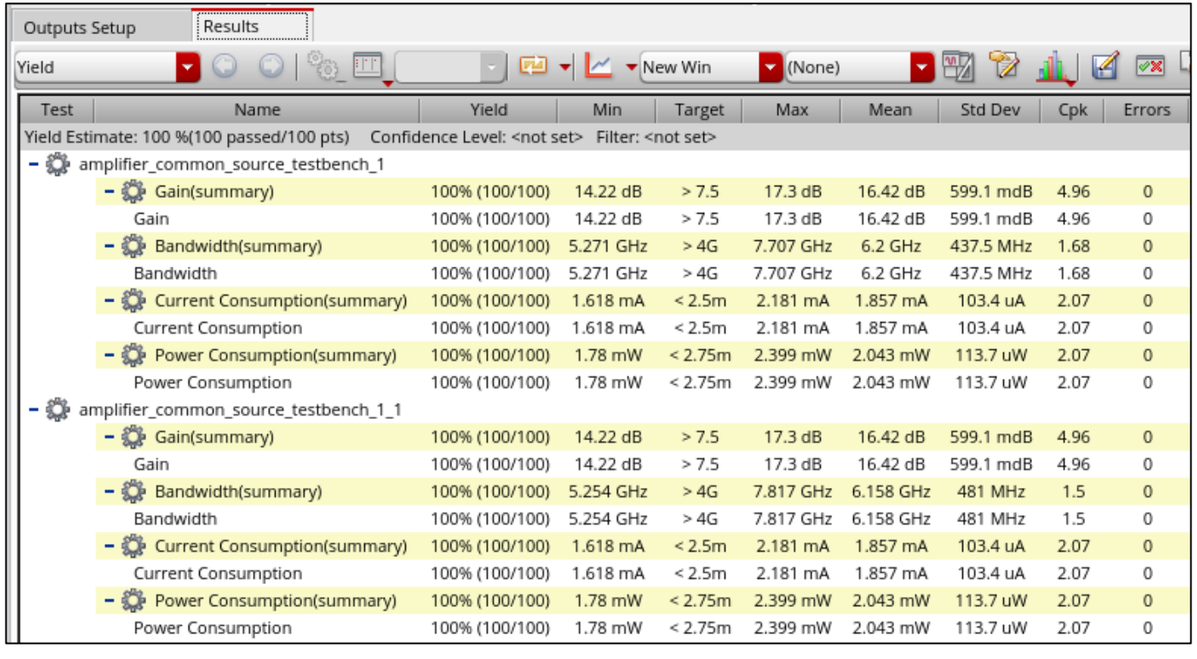
cadence

AMERICAN UNIVERSITY OF BEIRUT

- Migrating from ADE Explorer to ADE Assembler
- Sweeping Variables for each Testbench
- Measurements Across Sweeps and Corners
- **Monte Carlo Analysis**

4. Monte Carlo Analysis *(continued)*

- The results are displayed in the “Yield” format as shown in the figure.
- Since the added testbench is just another copy of the original testbench, the results are the same. We can benefit from this feature when we have different tests.
- Close the Assembler session and save the setup if you like.



Test	Name	Yield	Min	Target	Max	Mean	Std Dev	Cpk	Errors
Yield Estimate: 100 %(100 passed/100 pts) Confidence Level: <not set> Filter: <not set>									
	amplifier_common_source_testbench_1								
	Gain(summary)	100% (100/100)	14.22 dB	> 7.5	17.3 dB	16.42 dB	599.1 mdB	4.96	0
	Gain	100% (100/100)	14.22 dB	> 7.5	17.3 dB	16.42 dB	599.1 mdB	4.96	0
	Bandwidth(summary)	100% (100/100)	5.271 GHz	> 4G	7.707 GHz	6.2 GHz	437.5 MHz	1.68	0
	Bandwidth	100% (100/100)	5.271 GHz	> 4G	7.707 GHz	6.2 GHz	437.5 MHz	1.68	0
	Current Consumption(summary)	100% (100/100)	1.618 mA	< 2.5m	2.181 mA	1.857 mA	103.4 uA	2.07	0
	Current Consumption	100% (100/100)	1.618 mA	< 2.5m	2.181 mA	1.857 mA	103.4 uA	2.07	0
	Power Consumption(summary)	100% (100/100)	1.78 mW	< 2.75m	2.399 mW	2.043 mW	113.7 uW	2.07	0
	Power Consumption	100% (100/100)	1.78 mW	< 2.75m	2.399 mW	2.043 mW	113.7 uW	2.07	0
	amplifier_common_source_testbench_1_1								
	Gain(summary)	100% (100/100)	14.22 dB	> 7.5	17.3 dB	16.42 dB	599.1 mdB	4.96	0
	Gain	100% (100/100)	14.22 dB	> 7.5	17.3 dB	16.42 dB	599.1 mdB	4.96	0
	Bandwidth(summary)	100% (100/100)	5.254 GHz	> 4G	7.817 GHz	6.158 GHz	481 MHz	1.5	0
	Bandwidth	100% (100/100)	5.254 GHz	> 4G	7.817 GHz	6.158 GHz	481 MHz	1.5	0
	Current Consumption(summary)	100% (100/100)	1.618 mA	< 2.5m	2.181 mA	1.857 mA	103.4 uA	2.07	0
	Current Consumption	100% (100/100)	1.618 mA	< 2.5m	2.181 mA	1.857 mA	103.4 uA	2.07	0
	Power Consumption(summary)	100% (100/100)	1.78 mW	< 2.75m	2.399 mW	2.043 mW	113.7 uW	2.07	0
	Power Consumption	100% (100/100)	1.78 mW	< 2.75m	2.399 mW	2.043 mW	113.7 uW	2.07	0

cadence