Virtuoso 23.1
Module 5 – Monte Carlo Statistical Analysis

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Contents

Module Objective

In this module, we will learn how to:

- run a Monte Carlo analysis
- display the process and mismatch variations of an iteration

Monte Carlo Statistical Analysis

Monte Carlo Statistical Analysis

- Monte Carlo is a technique used to forecast all the possible outcomes of a circuit design by randomizing its parameters and variables, thus generating a full set of device models.

- Due to imperfections during fabrication, variations subsist. These variations can be:
  - Local (mismatch)
  - Global (process)

- Process Variations are the variations from wafer to wafer; while Mismatch Variation is a variation of two components across the same wafer, which generates for example input offsets in OpAmps and Comparators.

- Monte Carlo simulations give a more realistic insight into the design performance than corner simulations.

Monte Carlo Statistical Analysis *(continued)*

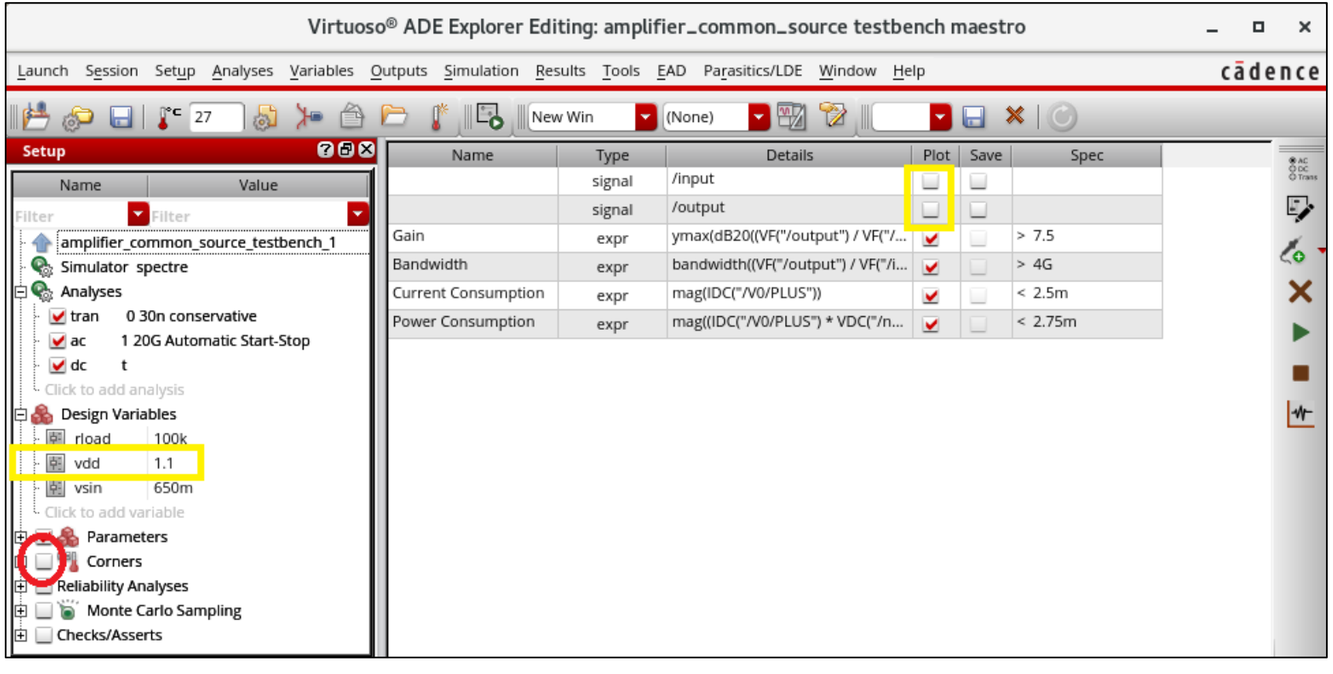
- Since Monte Carlo Analysis simply mimics the variability of the fabrication process, both of the variations can be simulated in Monte Carlo.

- ADE Explorer provides the ability to run Monte Carlo simulations so you can:
  - Estimate the yield of your design.
  - Generate information about the performance of your circuit design.

- Yield is the unit of measure for statistical design. It is defined as the ratio of the number of designs that pass the performance specifications to the total number of designs that are produced. It may also be thought of as the probability that a given design sample will pass the specifications.

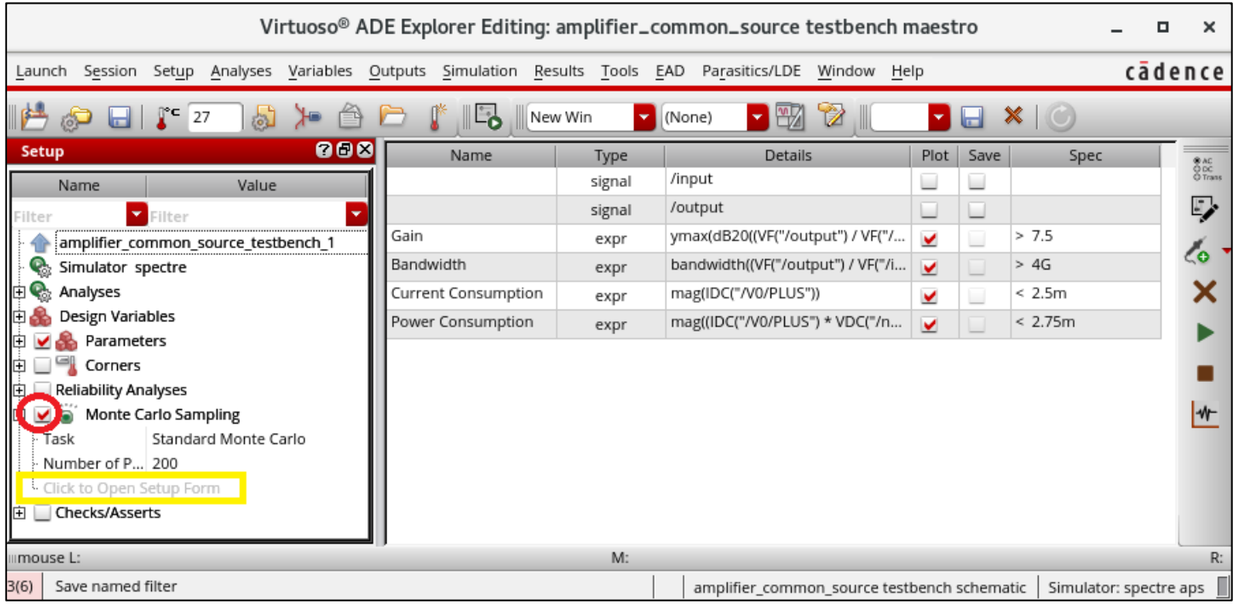
Monte Carlo Statistical Analysis *(continued)*

- Select the “amplifier_common_source” library, the “testbench” cell, and double click on the maestro view.
- To run Monte Carlo, make sure that Corners are unchecked, and Sweeps are removed. Also, uncheck the Plot of the output and input expressions.



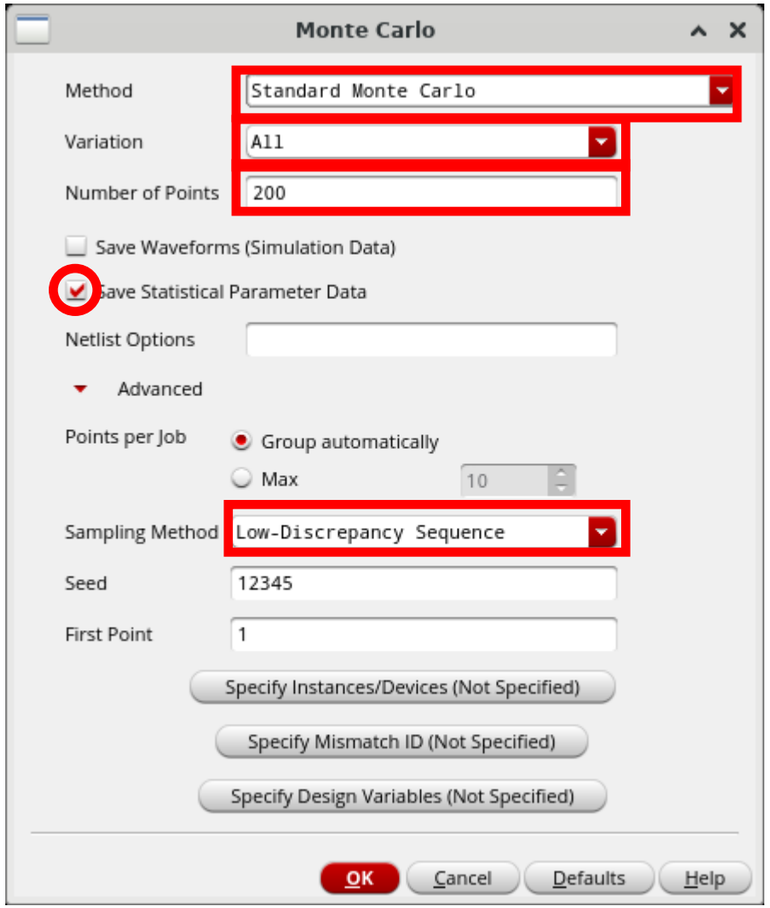
Monte Carlo Statistical Analysis *(continued)*

- Check the **Monte Carlo Sampling** checkbox, then click on **Click to Open Setup Form**.



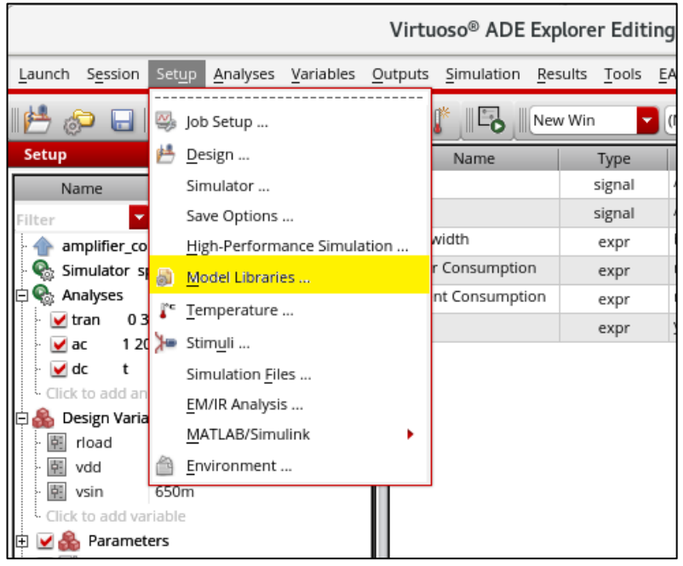
Monte Carlo Statistical Analysis *(continued)*

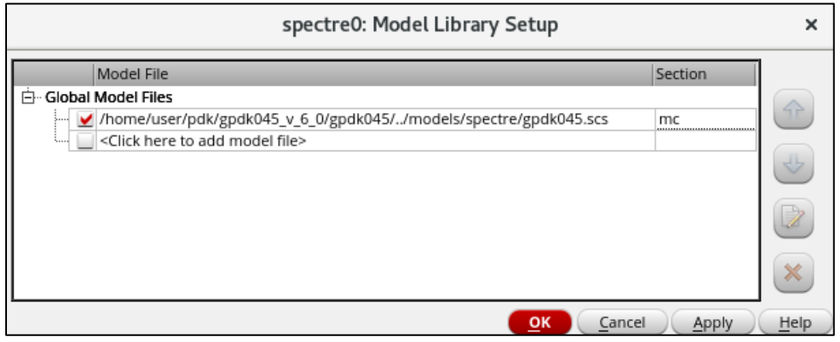
- Notice that ADE Explorer provides a variety of advanced statistical simulation algorithms beside the “Standard Monte Carlo” method.
- Under Variation you can choose to simulate “Mismatch”, “Process” or “All”.
- Set the “Number Of Points” to 200.
- Click on **Advanced**.
- Make sure the “Sampling Method” is set to Low-Discrepancy Sequence.
- Click on **OK**.



Monte Carlo Statistical Analysis *(continued)*

- Make sure that the process corner “**mc**” is selected.



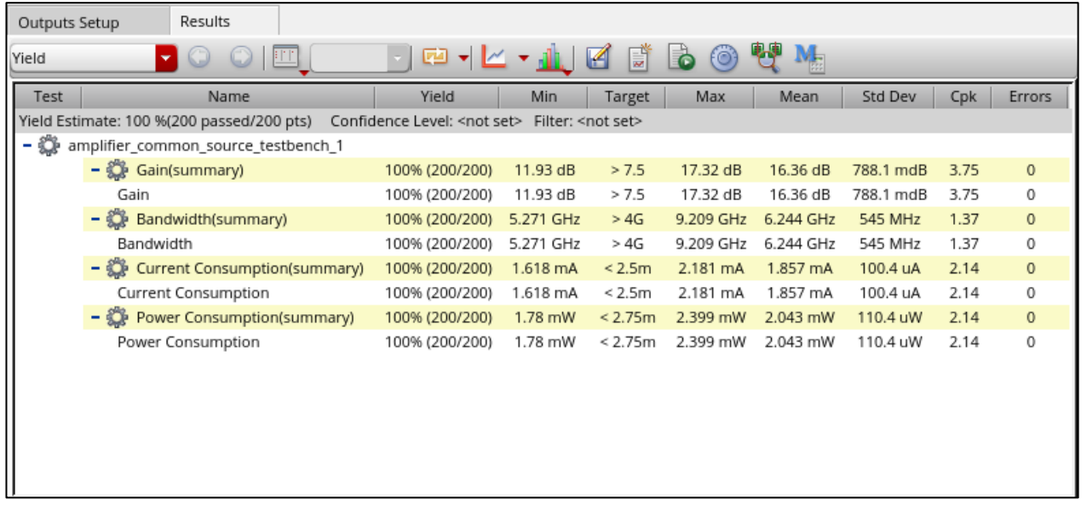


- Click on the green **Run Simulation** icon on the right side of your window.
- Expressions in the Output Setup tab that have the “Plot” enabled, will have a histogram plotted.

- If the Model Library is not set, please check Module 3 slide 14.

Monte Carlo Statistical Analysis *(continued)*

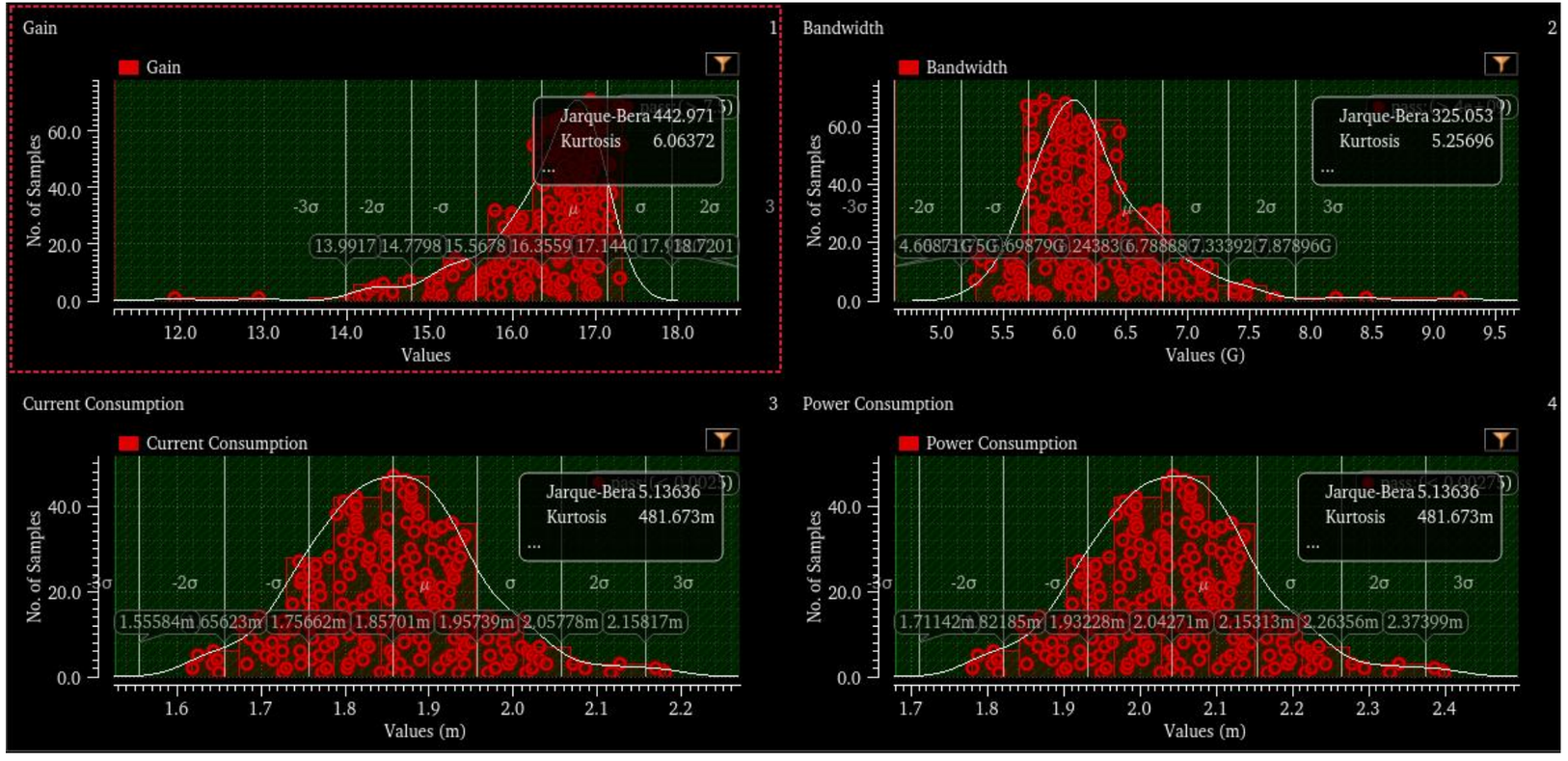
- The display changes automatically to “Yield”.
- The number of passing and failing trials is recorded and these numbers are used to compute an estimate of the yield.
- The yield for each output is displayed along with a total estimated yield.
- The Yield Estimate in this case is 100%. Note that it is usually quite difficult to meet all corners (100% yield).



Test	Name	Yield	Min	Target	Max	Mean	Std Dev	Cpk	Errors
Yield Estimate: 100 %(200 passed/200 pts)	Confidence Level: <not set>	Filter: <not set>							
	amplifier_common_source_testbench_1								
	Gain(summary)	100% (200/200)	11.93 dB	> 7.5	17.32 dB	16.36 dB	788.1 mdB	3.75	0
	Gain	100% (200/200)	11.93 dB	> 7.5	17.32 dB	16.36 dB	788.1 mdB	3.75	0
	Bandwidth(summary)	100% (200/200)	5.271 GHz	> 4G	9.209 GHz	6.244 GHz	545 MHz	1.37	0
	Bandwidth	100% (200/200)	5.271 GHz	> 4G	9.209 GHz	6.244 GHz	545 MHz	1.37	0
	Current Consumption(summary)	100% (200/200)	1.618 mA	< 2.5m	2.181 mA	1.857 mA	100.4 uA	2.14	0
	Current Consumption	100% (200/200)	1.618 mA	< 2.5m	2.181 mA	1.857 mA	100.4 uA	2.14	0
	Power Consumption(summary)	100% (200/200)	1.78 mW	< 2.75m	2.399 mW	2.043 mW	110.4 uW	2.14	0
	Power Consumption	100% (200/200)	1.78 mW	< 2.75m	2.399 mW	2.043 mW	110.4 uW	2.14	0

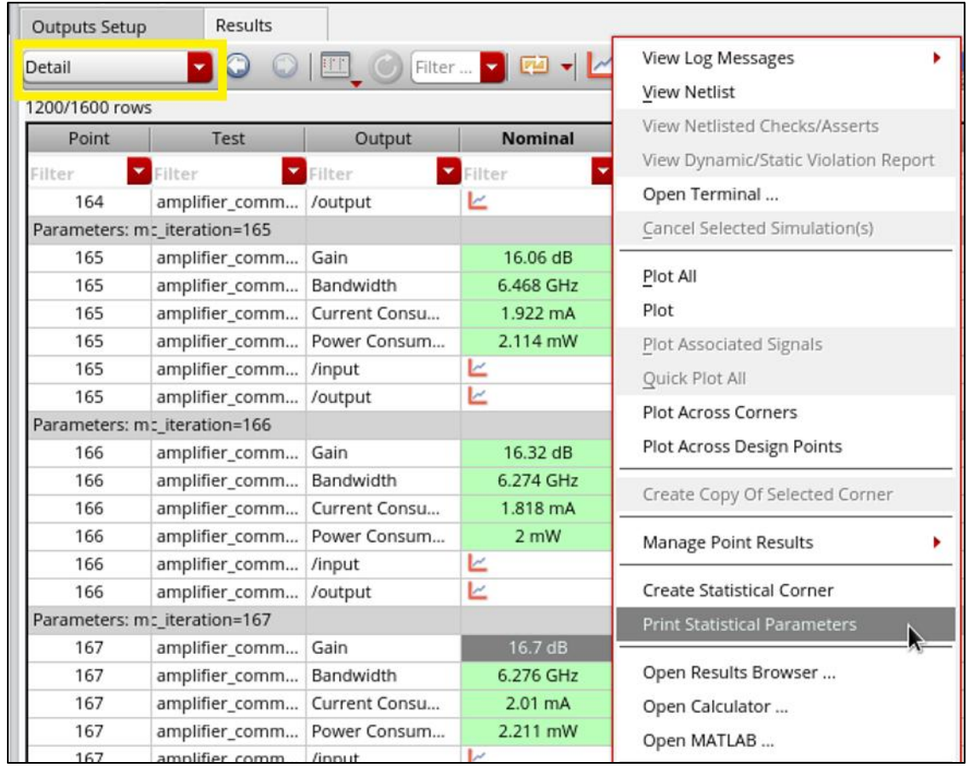
Monte Carlo Statistical Analysis *(continued)*

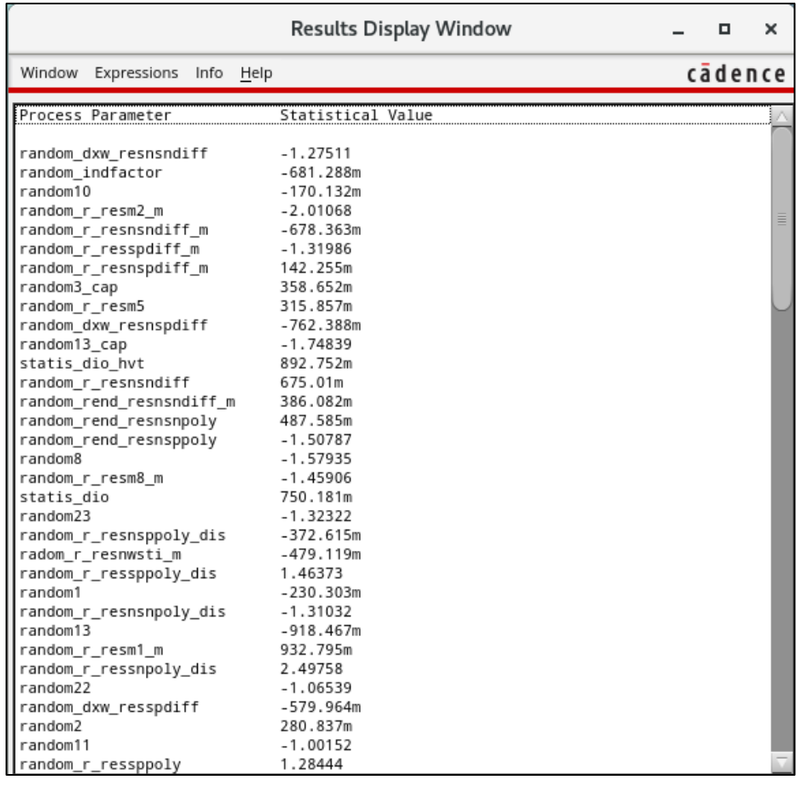
- The results are also plotted using a histogram for each output expression.
- The Gain, Bandwidth, Current and Power Consumption pass all 200 iterations of corners.



Monte Carlo Statistical Analysis *(continued)*

- To delve deeper into a design specification, consider exploring the "Detail" display view and selecting the design point. In this investigation, right-click on the point and choose "Print Statistical Parameters."
- This approach allows a more comprehensive examination of the process.

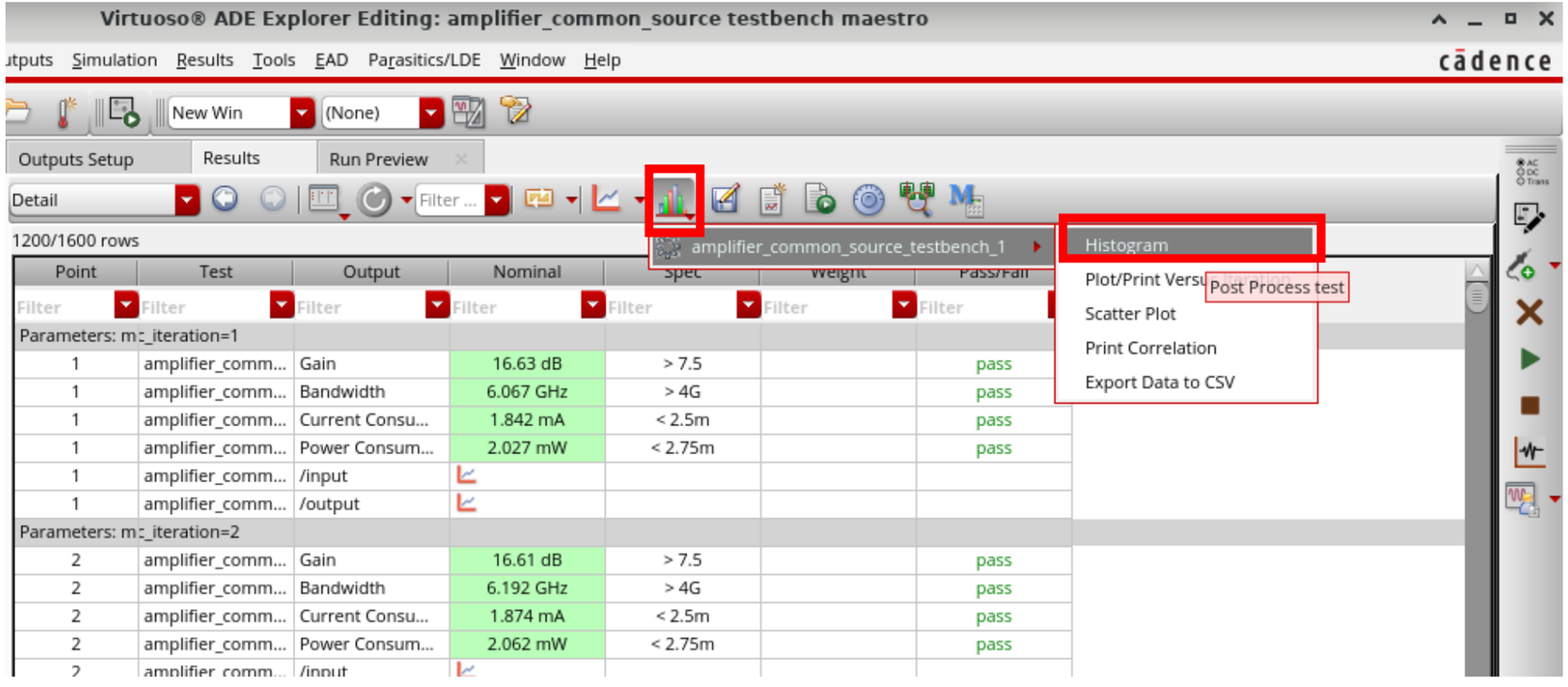




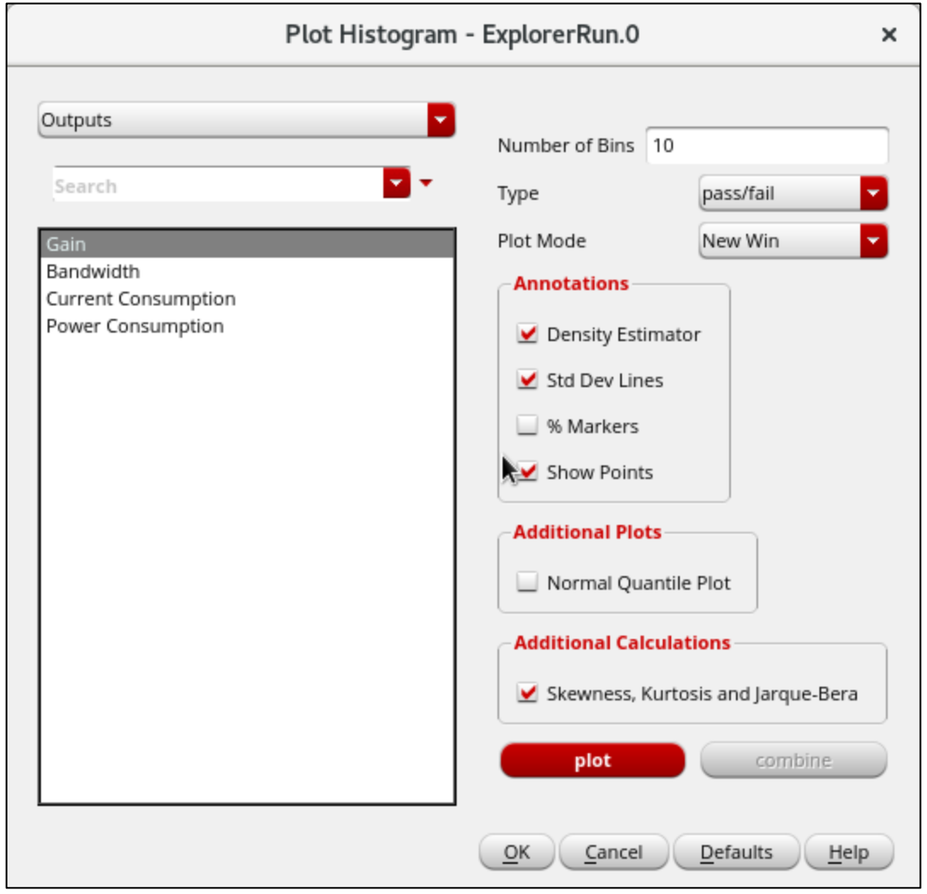
- Note that this technique is mostly used in the event of a design point failure.

Monte Carlo Statistical Analysis *(continued)*

- You can also plot the histogram for any of the outputs, select the **Post Processing operations for Monte Carlo** icon → **amplifier_common_source_testbench_1** → **Histogram**.



Monte Carlo Statistical Analysis *(continued)*



- Select the output you want to plot, and accordingly choose the **Number of Bins**, **Type**, etc., then click on **plot**.