Loop Stability Analysis

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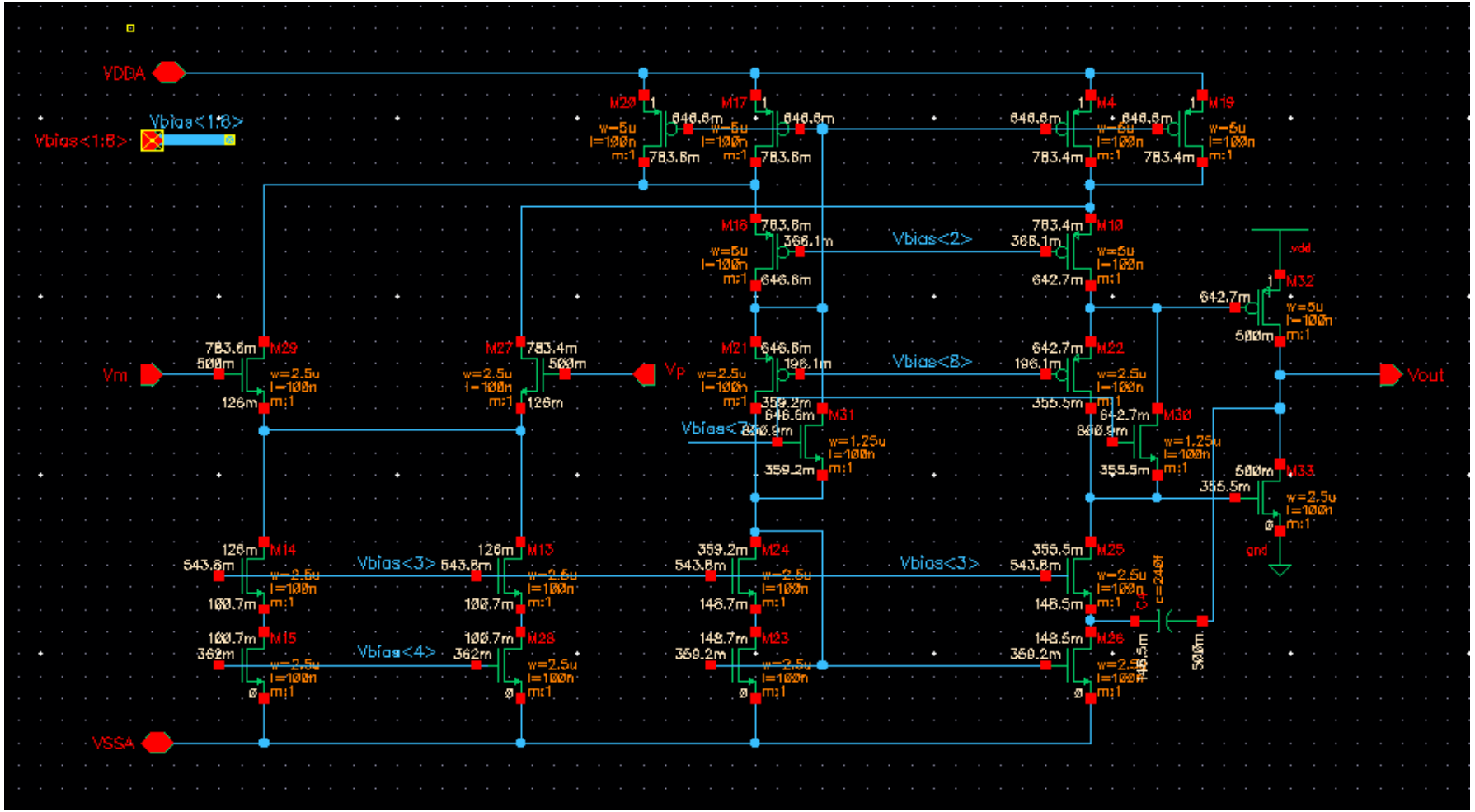
Spectre STB Analysis

- The STB analysis linearizes the circuit about the DC operating point and computes the loop-gain, gain and phase margins (if the sweep variable is frequency), for a feedback loop or a gain device [1].
- Refer to the Spectre Simulation Refrence [1] and [2] for details.

Example Single-ended Opamp Schematic



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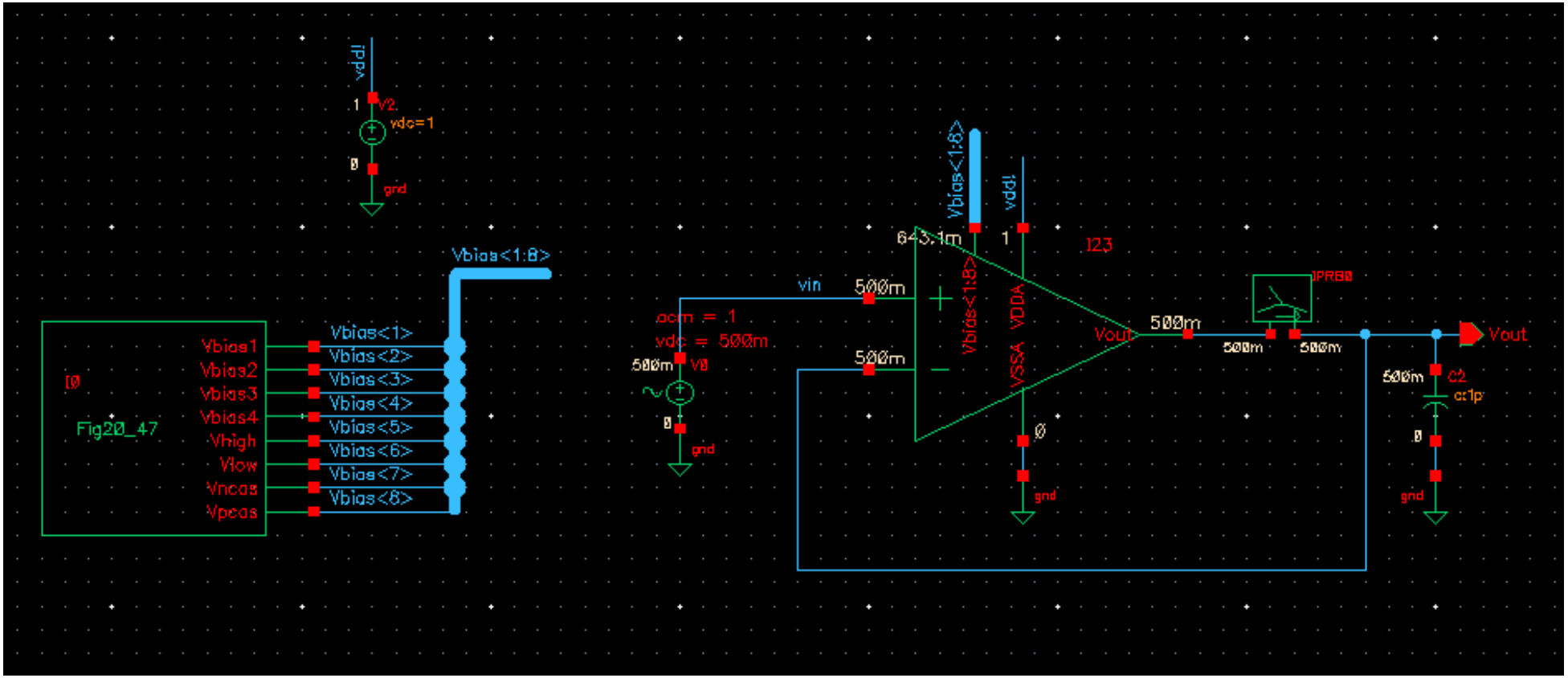
STB Analysis Test Bench



- Pay attention to the **iprobe** component (from analogLib)
  - Acts as a short for DC, but breaks the loop in stb analysis
- Place the probe at a point where it completely breaks (all) the loop(s).

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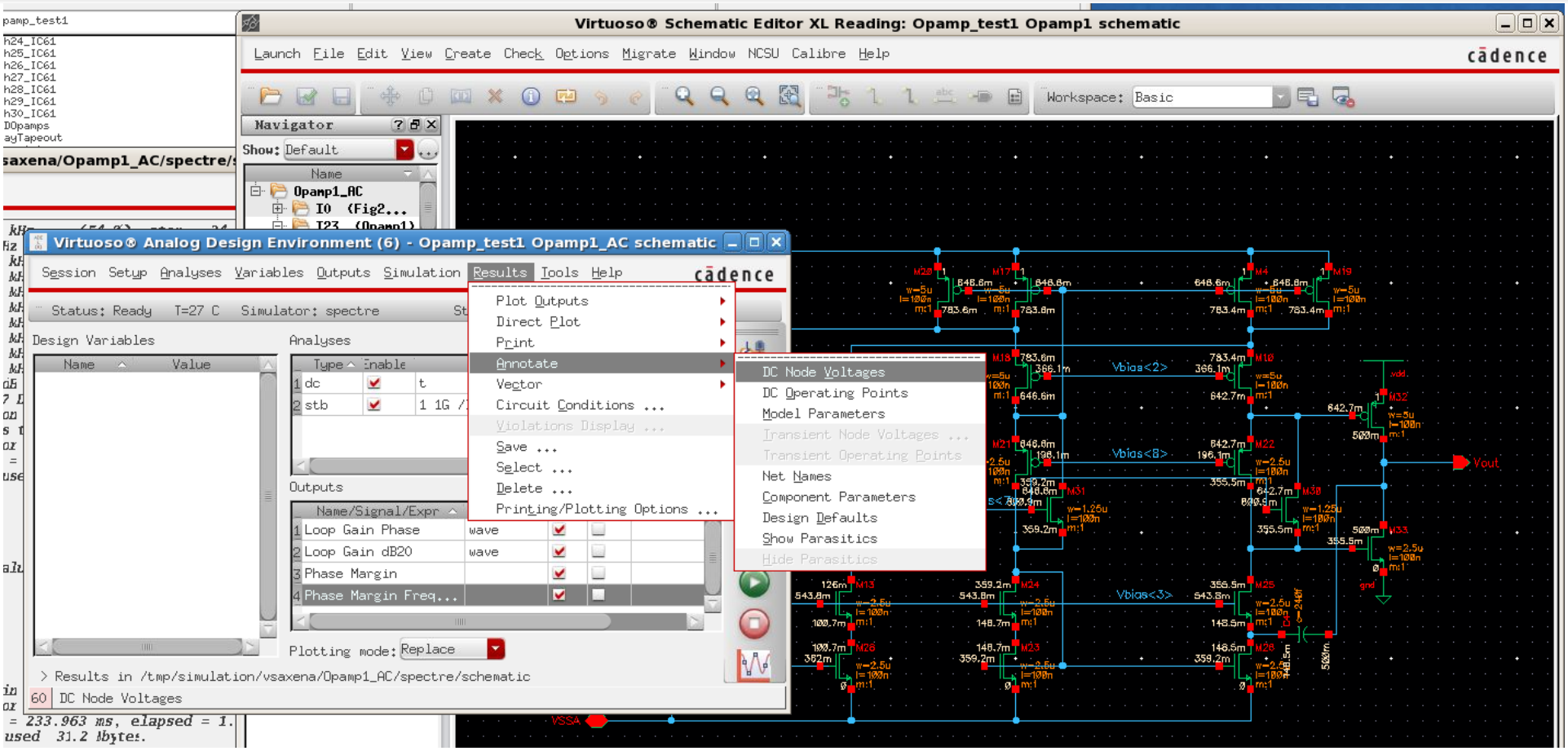
DC Annotation



- Annotating the node voltages and DC operating points of the devices helps debug the design
  - Check device gds to see if its in triode or saturation regions

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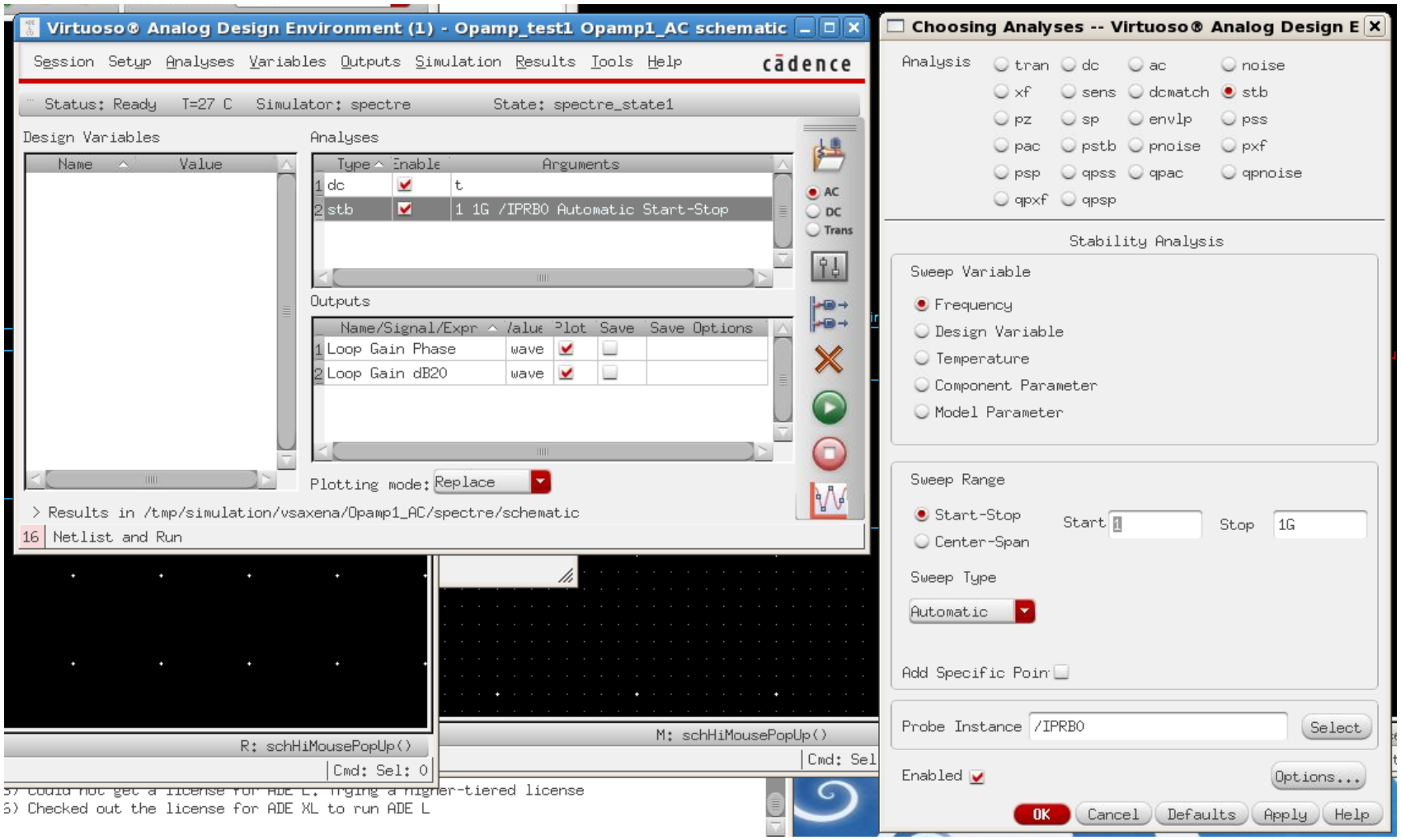
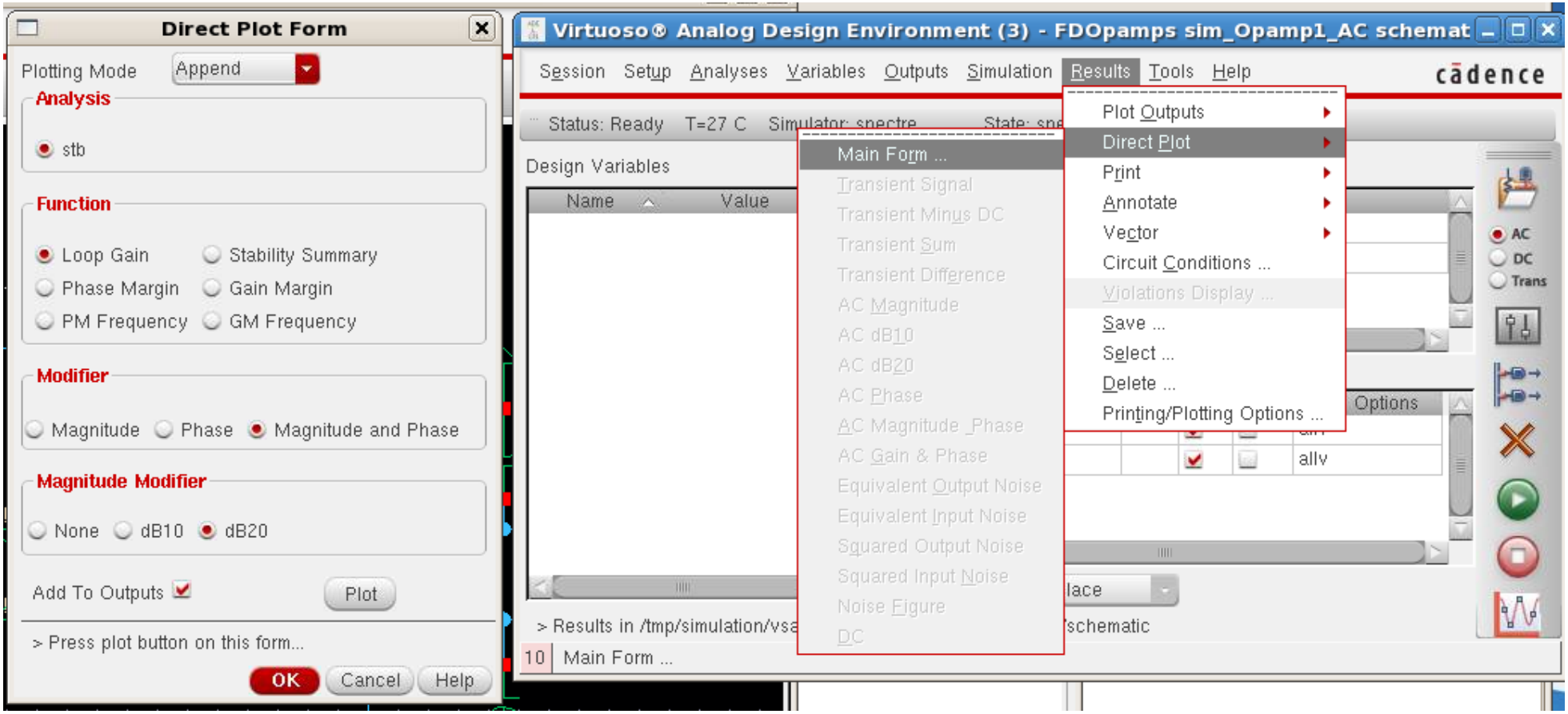
Simulation Setup



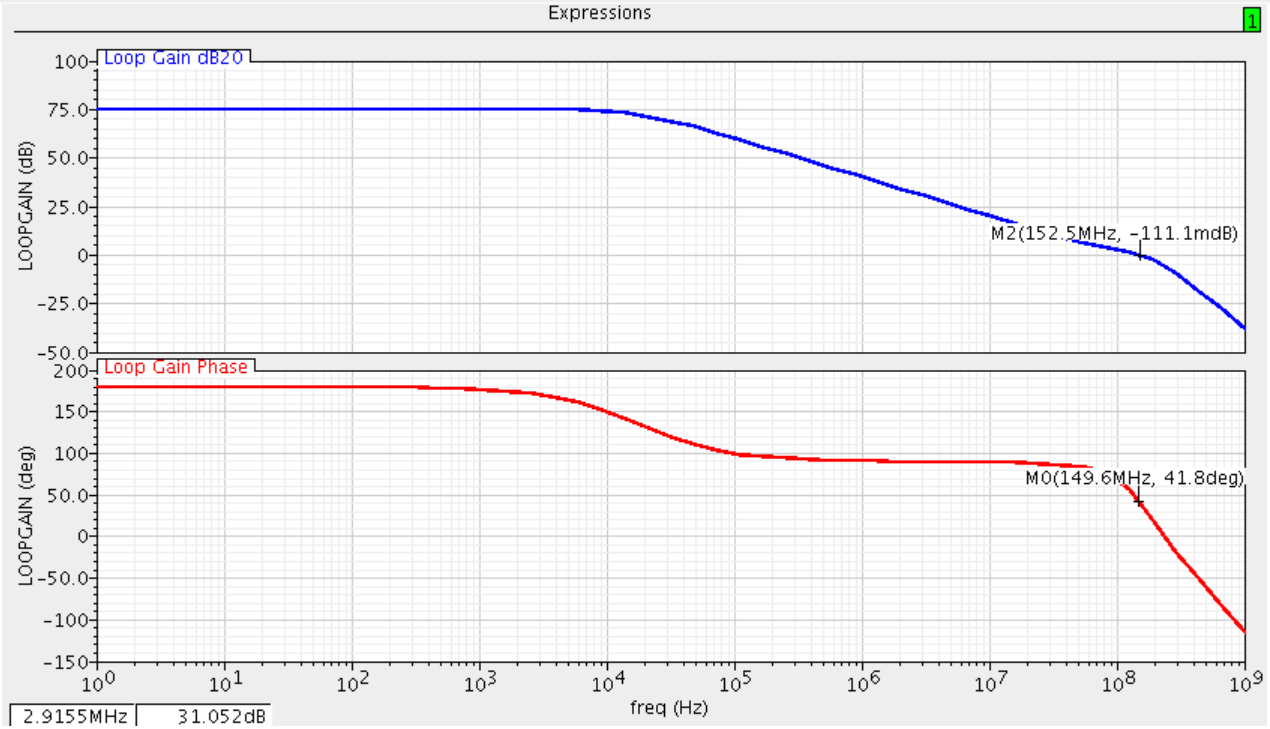
- Always have dc analysis on for debugging purpose

Bode Plot Setup



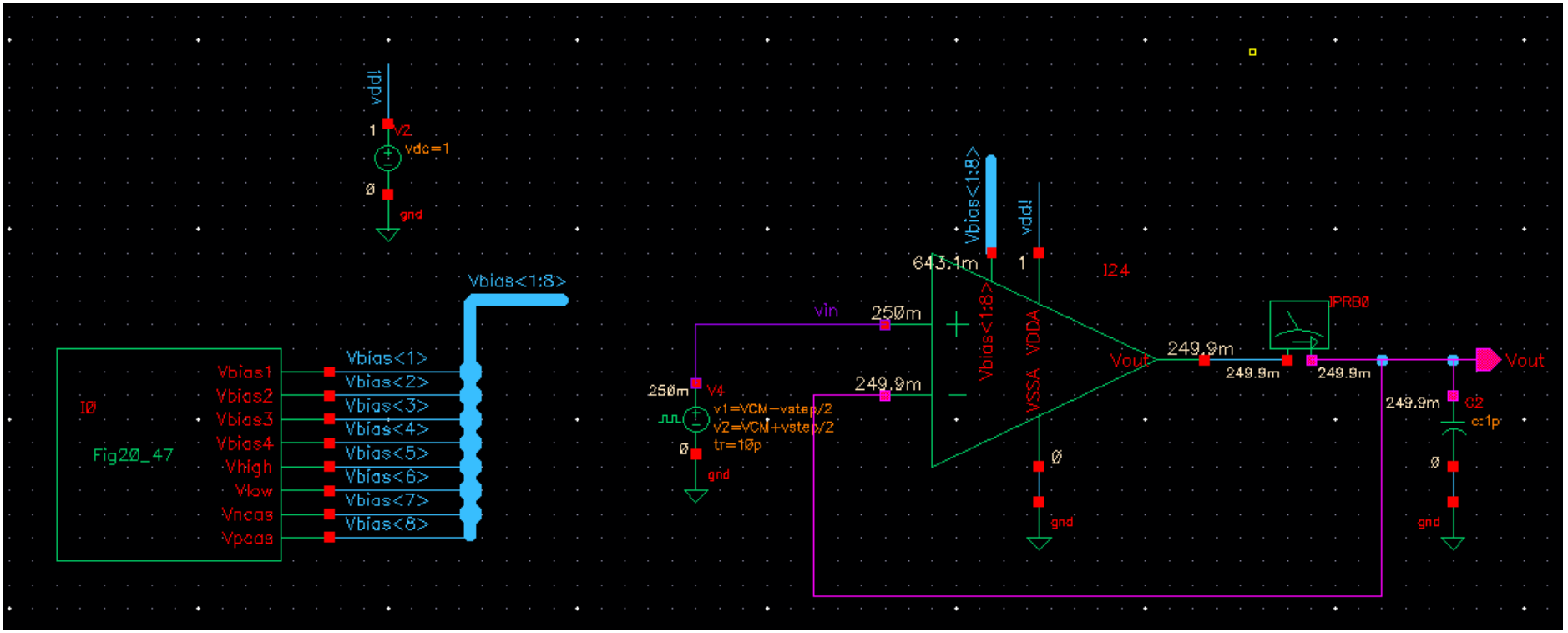
- **Results->Direct Plot-> Main Form**

Open Loop Response Bode Plots



- Here, f_{un}=152.5 MHz, PM=41.8º
- Try to use the stb analysis while the circuit is in the desired feedback configuration
  - Break the loop with realistic DC operation points

Transient Step Response Test Bench



- Transient step-response verifies the closed-loop stability
- Use small as wells as large steps for characterization
- iprobe acts as a short (can remove it)

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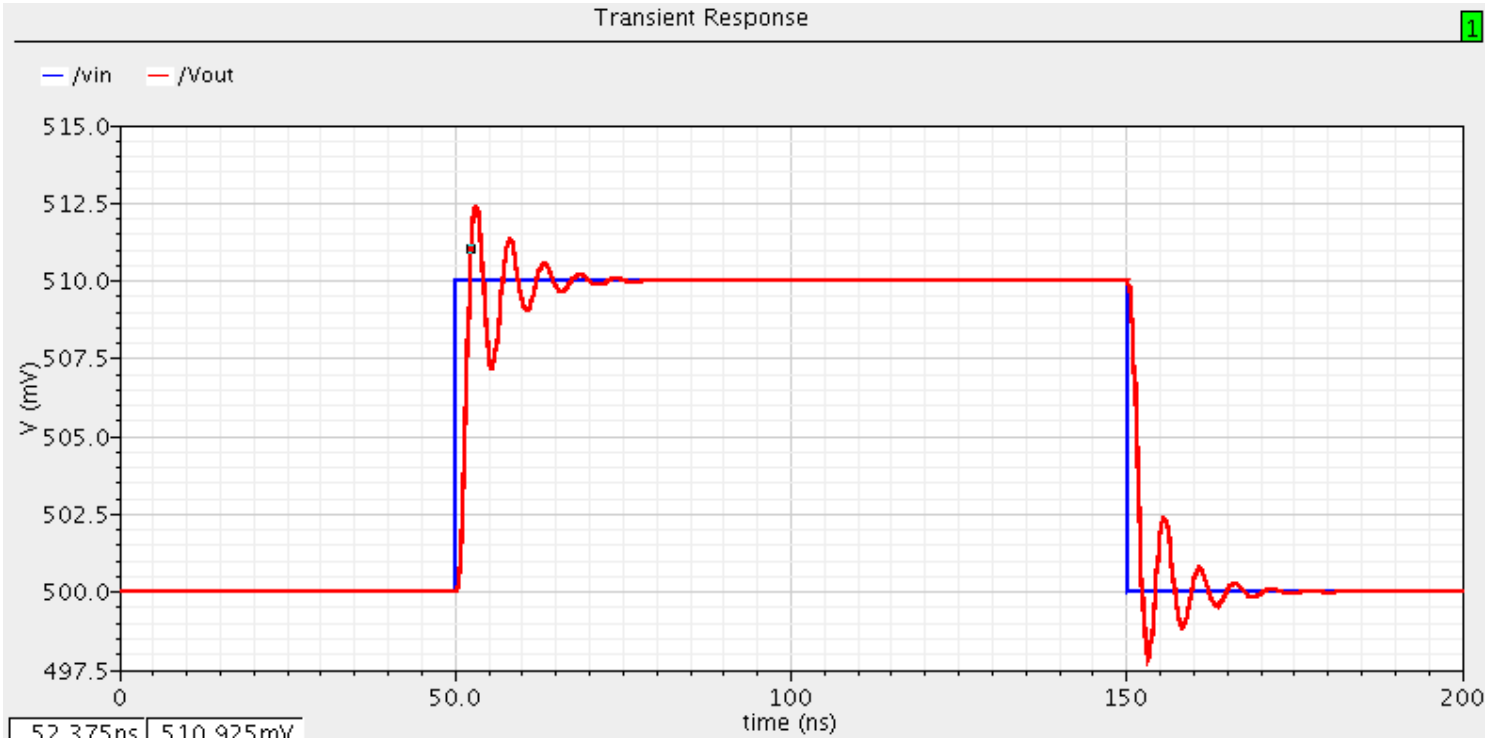
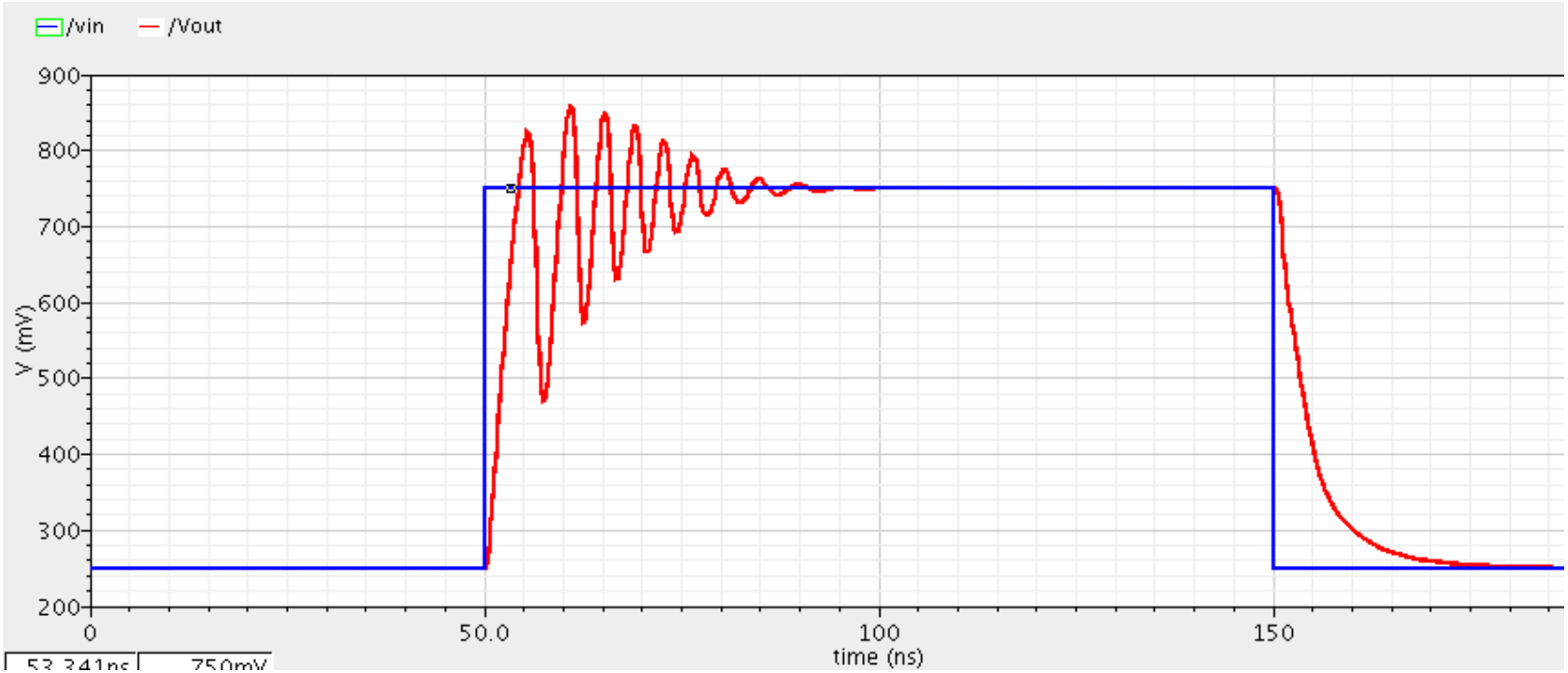
Small Step Response



- Observe the ringing (PM was 41º)
  - Compensate more

Large Step Response



- Note the slewing in the output

References

[1] Spectre User Simulation Guide, pages 160-165

http://www.designers-guide.org/Forum/YaBB.pl?num=1170321868

[2] M. Tian, V. Viswanathan, J. Hangtan, K. Kundert, “Striving for Small-Signal Stability: Loop-based and Device-based Algorithms for Stability Analysis of Linear Analog Circuits in the Frequency Domain,” Circuits and Devices, Jan 2001.

http://www.kenkundert.com/docs/cd2001-01.pdf

[3] https://secure.engr.oregonstate.edu/wiki/ams/index.php/Spectre/STB