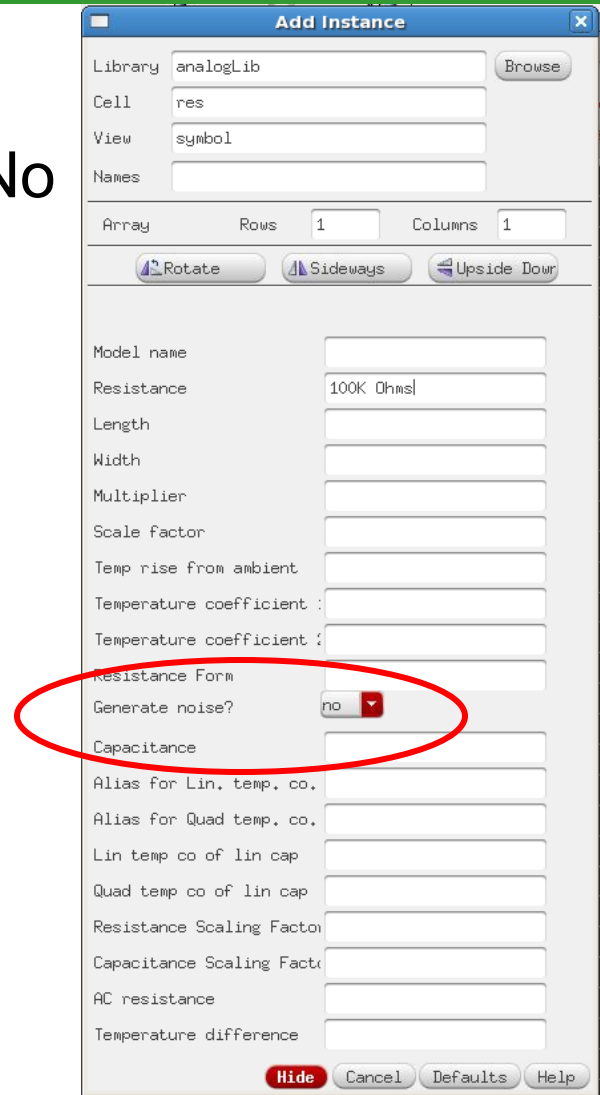
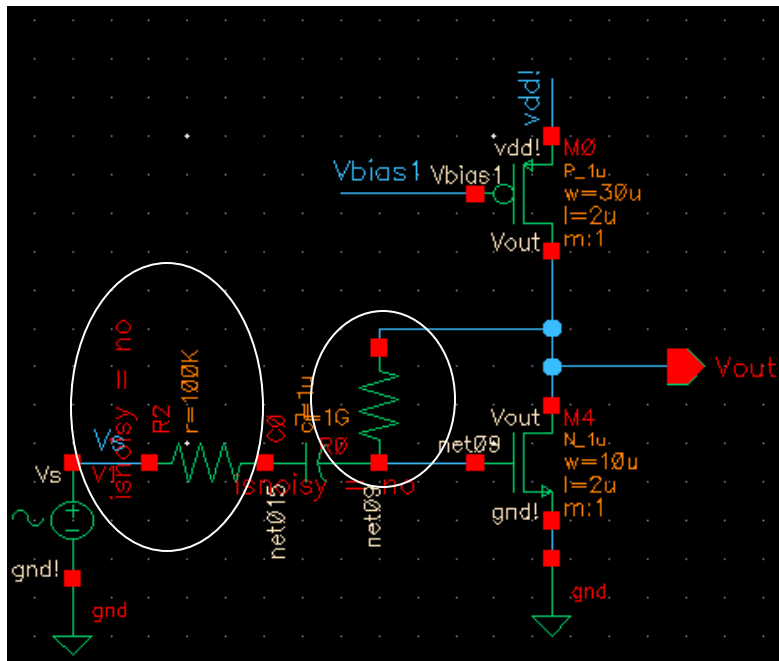


Spectre Noise Analysis

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Making Resistors Noiseless

- ❑ Use AnalogLib→res component
- ❑ Set “Generate noise” parameter to No



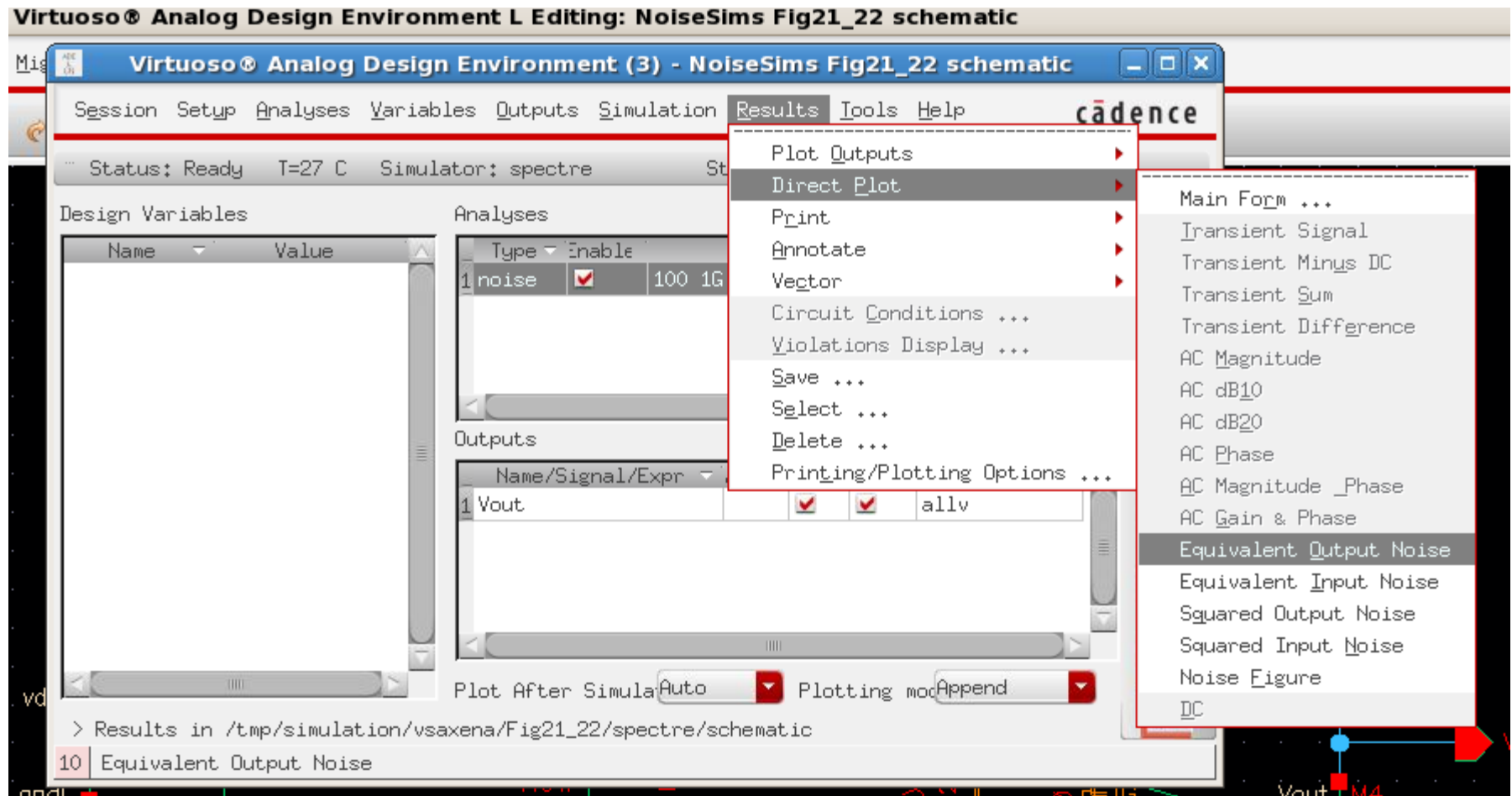
.noise Analysis

The screenshot displays the Cadence Virtuoso Analog Design Environment interface for a noise analysis simulation. The main window shows a schematic diagram of a circuit with components like resistors, capacitors, and a voltage source. The circuit is labeled with various nodes and components, including V_{bias1} , V_{dd} , V_{out} , and V_{in} .

On the left, the "Virtuoso® Analog Design Environment (3) - NoiseSims Fig21_22 schematic" window is open, showing the "Analyses" tab. The "noise" analysis is selected, and the "Type" is set to "noise". The "Arguments" field contains "100 1G Automatic Start-Stop /Vout...". The "Outputs" table shows the output signal V_{out} and the plot type "allv".

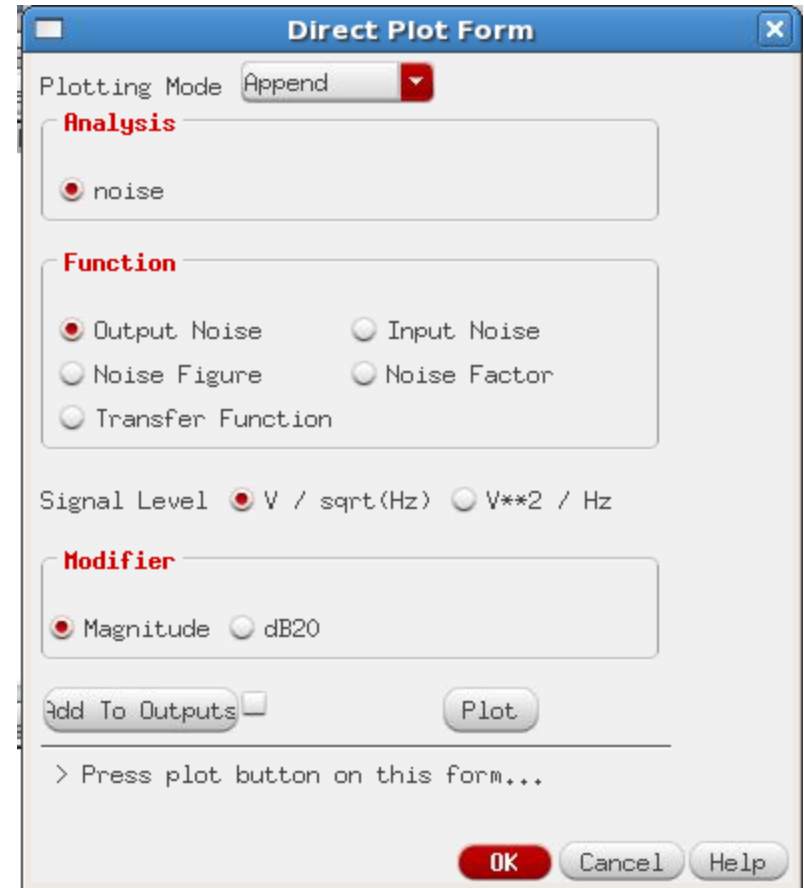
On the right, the "Choosing Analyses -- Virtuoso® Analog Design E" dialog box is open, showing the "Noise Analysis" section. The "Sweep Variable" is set to "Frequency". The "Sweep Range" is set to "Start-Stop" with "Start" at 100 and "Stop" at 1G. The "Sweep Type" is set to "Automatic". The "Output Noise" section is highlighted with a red circle, showing the "Positive Output Node" as $/Vout$ and the "Negative Output Node" as $/gnd1$. The "Input Noise" section shows the "Input Voltage Source" as $/V1$.

Plotting Results



Direct Plot Form

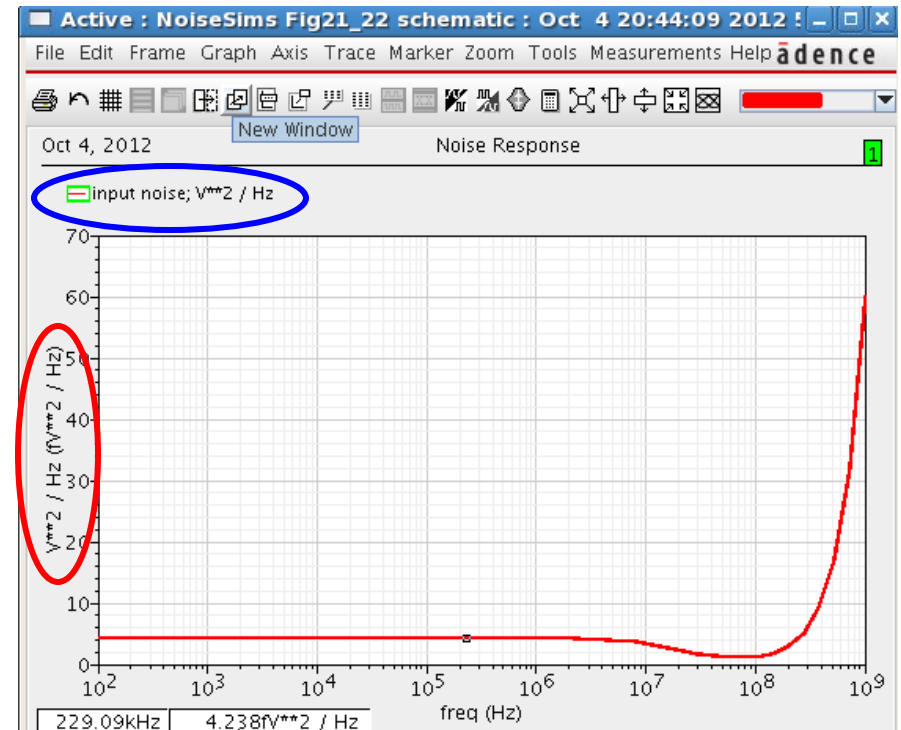
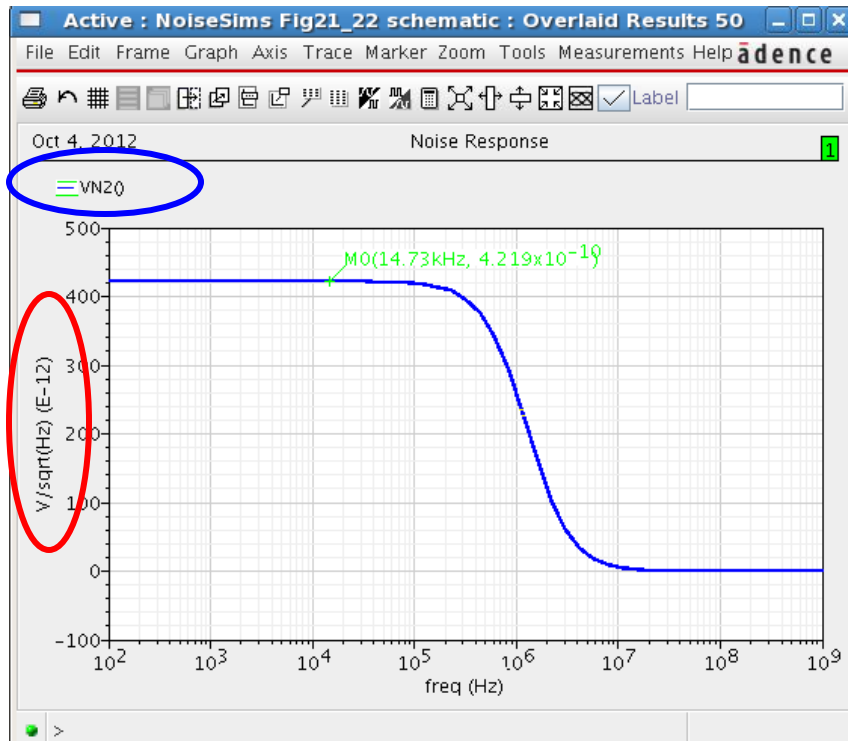
- ❑ Can change units to PSD or VSD
- ❑ Add plots to outputs



The image shows a software dialog box titled "Direct Plot Form". It contains several sections for configuring a plot:

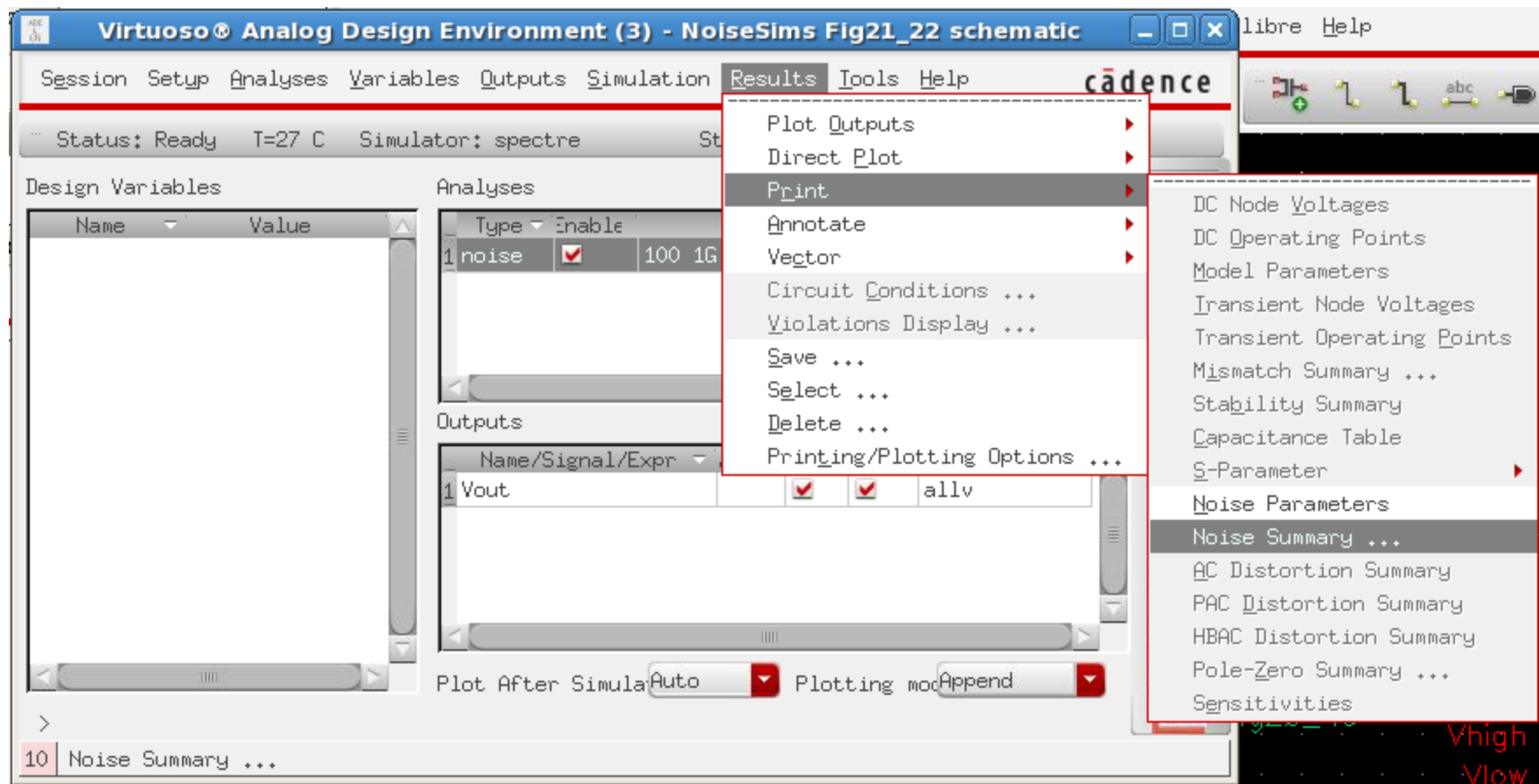
- Plotting Mode:** A dropdown menu set to "Append".
- Analysis:** A section with a single radio button labeled "noise".
- Function:** A section with five radio buttons: "Output Noise" (selected), "Input Noise", "Noise Figure", "Noise Factor", and "Transfer Function".
- Signal Level:** Two radio buttons: "V / sqrt(Hz)" (selected) and "V**2 / Hz".
- Modifier:** A section with two radio buttons: "Magnitude" (selected) and "dB20".
- Buttons:** "Add To Outputs" (disabled), "Plot" (active), "OK" (red), "Cancel", and "Help".
- Footer:** A text prompt "> Press plot button on this form..."

Plotting Results



- ❑ Note that this model didn't have flicker noise
- ❑ VN2() is output noise. Can plot input noise and change the units
- ❑ Understand the frequency response effects when plotting input noise and see if the plot makes sense!

Noise Summary Reports



Noise Summary Reports

Noise Summary

Print the output noise of 'noise' analysis

Type ☒ spot noise ☐ integrated noise noise unit V^2

Frequency Spot (Hz) 10K

FILTER

Include All Types mos
Include None resistor

include instance Select Clear

exclude instance /R1 /R0 Select Clear

TRUNCATE & SORT

truncate by number top 3

sort by ☒ noise contributors ☐ composite noise ☐ device name

OK Cancel Apply Help

Results Display Window

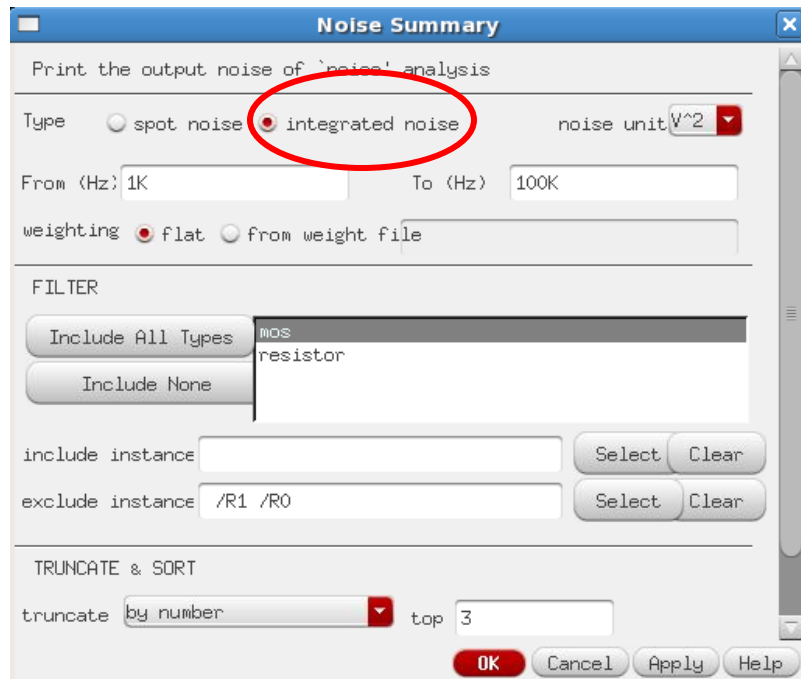
Window Expressions Info Help

cadence

Device	Param	Noise Contribution	% Of Total
/IO/M4	id	1,0401e-10	24,65
/IO/M3	id	9,99457e-11	23,69
/IO/M1	id	9,23857e-11	21,90

Spot Noise Summary (in V^2/Hz) at 10K Hz Sorted By Noise Contributors
Total Summarized Noise = 4,21907e-10
Total Input Referred Noise = 4,23866e-15
The above noise summary info is for noise data

Integrated Noise Summary



The 'Noise Summary' dialog box is shown with the 'integrated noise' radio button selected and circled in red. The 'noise unit' is set to V^2 . The frequency range is from 1K to 100K Hz. The weighting is set to 'flat'. The filter section shows 'Include All Types' with a list containing 'mos' and 'resistor'. The 'truncate & sort' section is set to 'by number' and 'top 3'.

Print the output noise of 'noise' analysis

Type ☐ spot noise ☒ integrated noise noise unit V^2

From (Hz): 1K To (Hz): 100K

weighting ☒ flat ☐ from weight file

FILTER

Include All Types mos
resistor

Include None

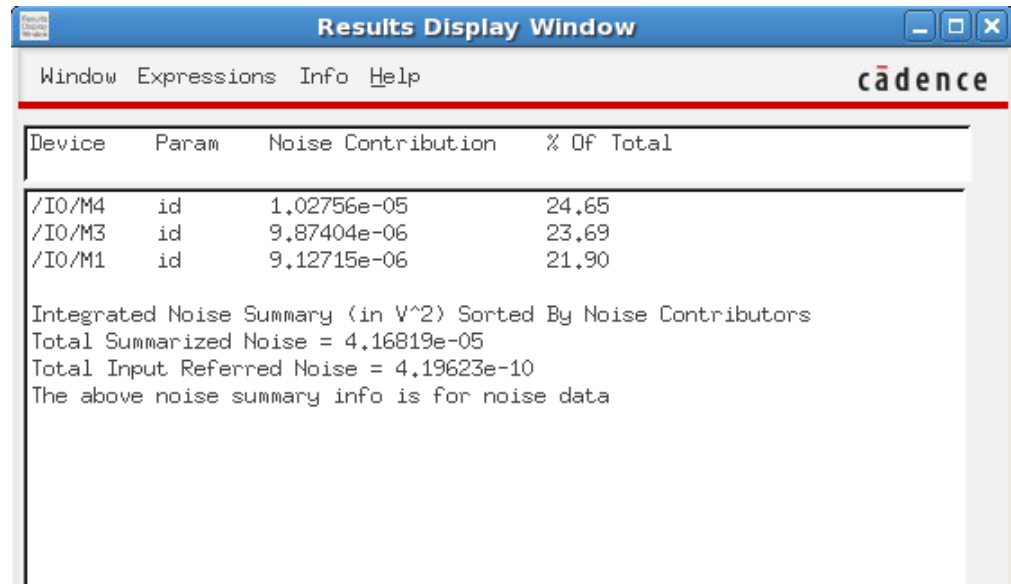
include instance Select Clear

exclude instance /R1 /R0 Select Clear

TRUNCATE & SORT

truncate by number top 3

OK Cancel Apply Help



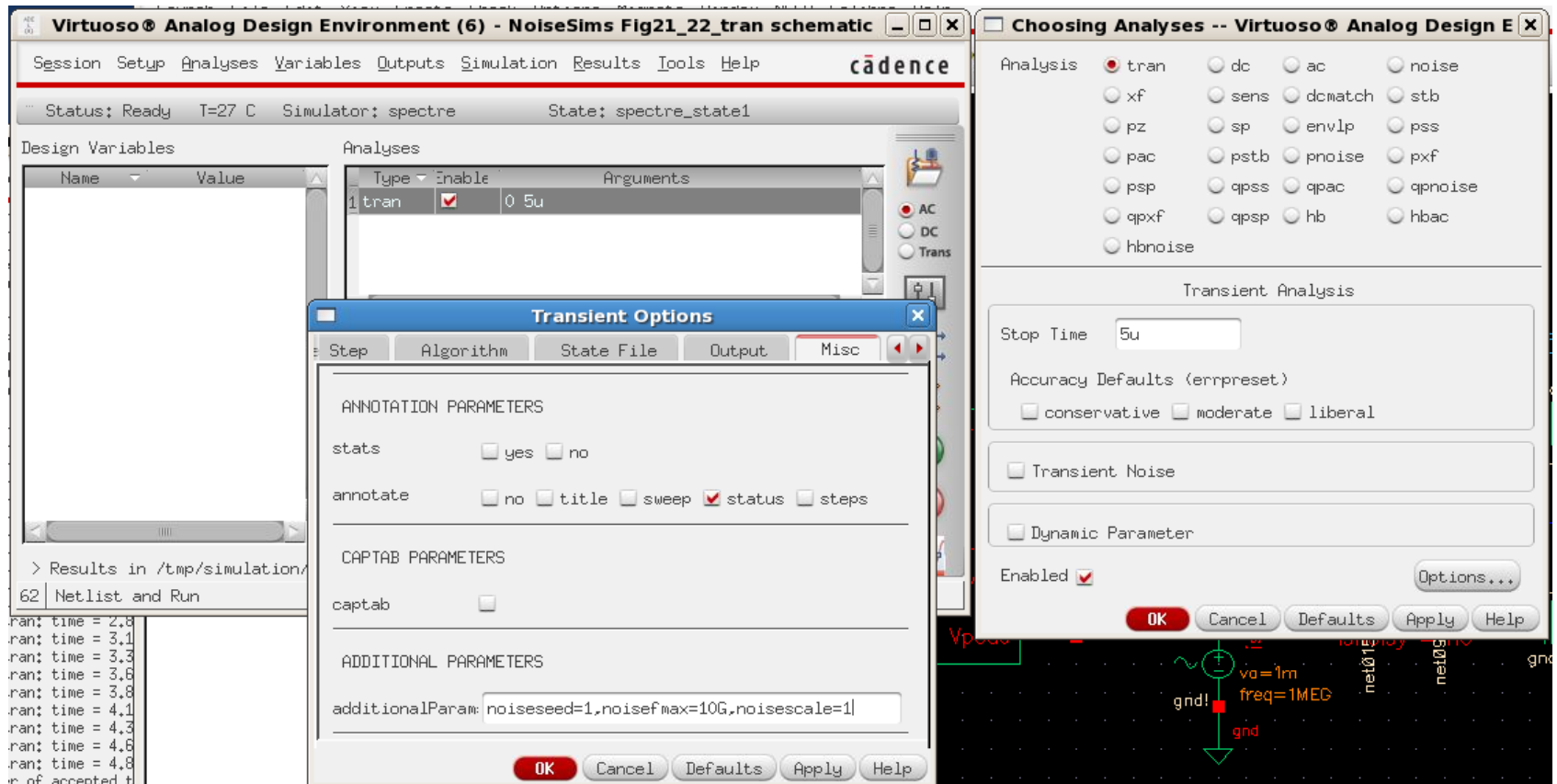
The 'Results Display Window' shows the integrated noise summary. It includes a table of noise contributors and a summary of the total noise.

Device	Param	Noise Contribution	% Of Total
/IO/M4	id	1.02756e-05	24.65
/IO/M3	id	9.87404e-06	23.69
/IO/M1	id	9.12715e-06	21.90

Integrated Noise Summary (in V^2) Sorted By Noise Contributors
Total Summarized Noise = 4.16819e-05
Total Input Referred Noise = 4.19623e-10
The above noise summary info is for noise data

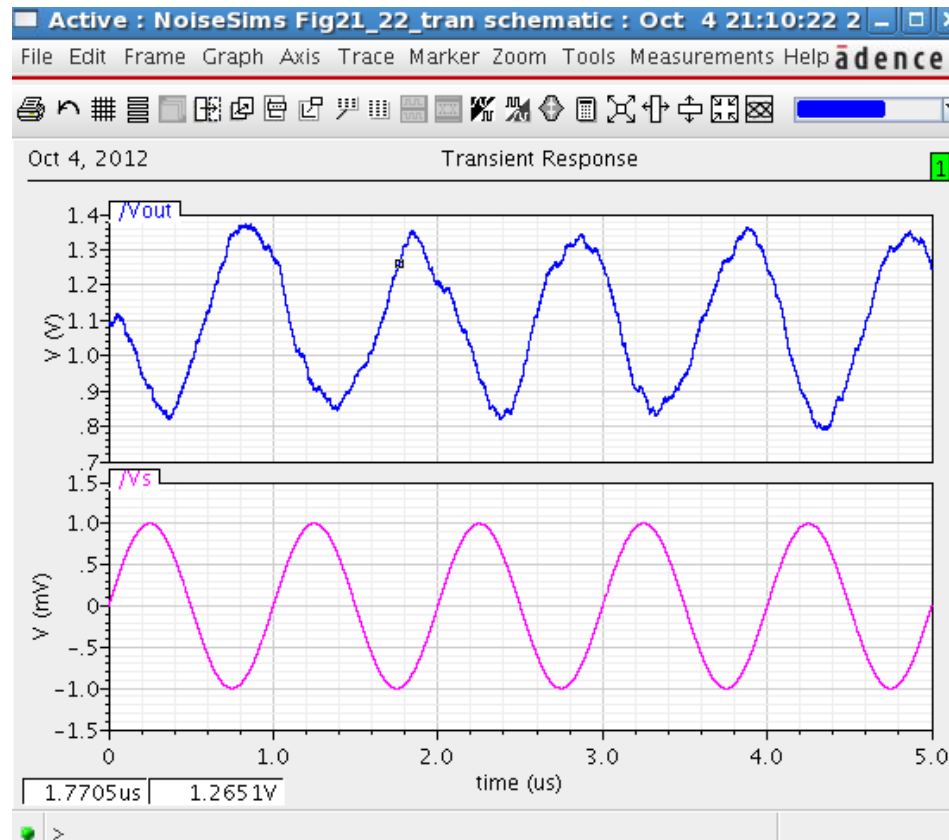
- ❑ Use the filters appropriately for the noise reports

Transient Noise Simulation



- ❑ Create a new transient simulation, open the transient options form, then add the transient noise parameters to the Additional Options field.
 - noiseseed=1,noisefmax=10G,noisescale=1

Transient Noise Simulation

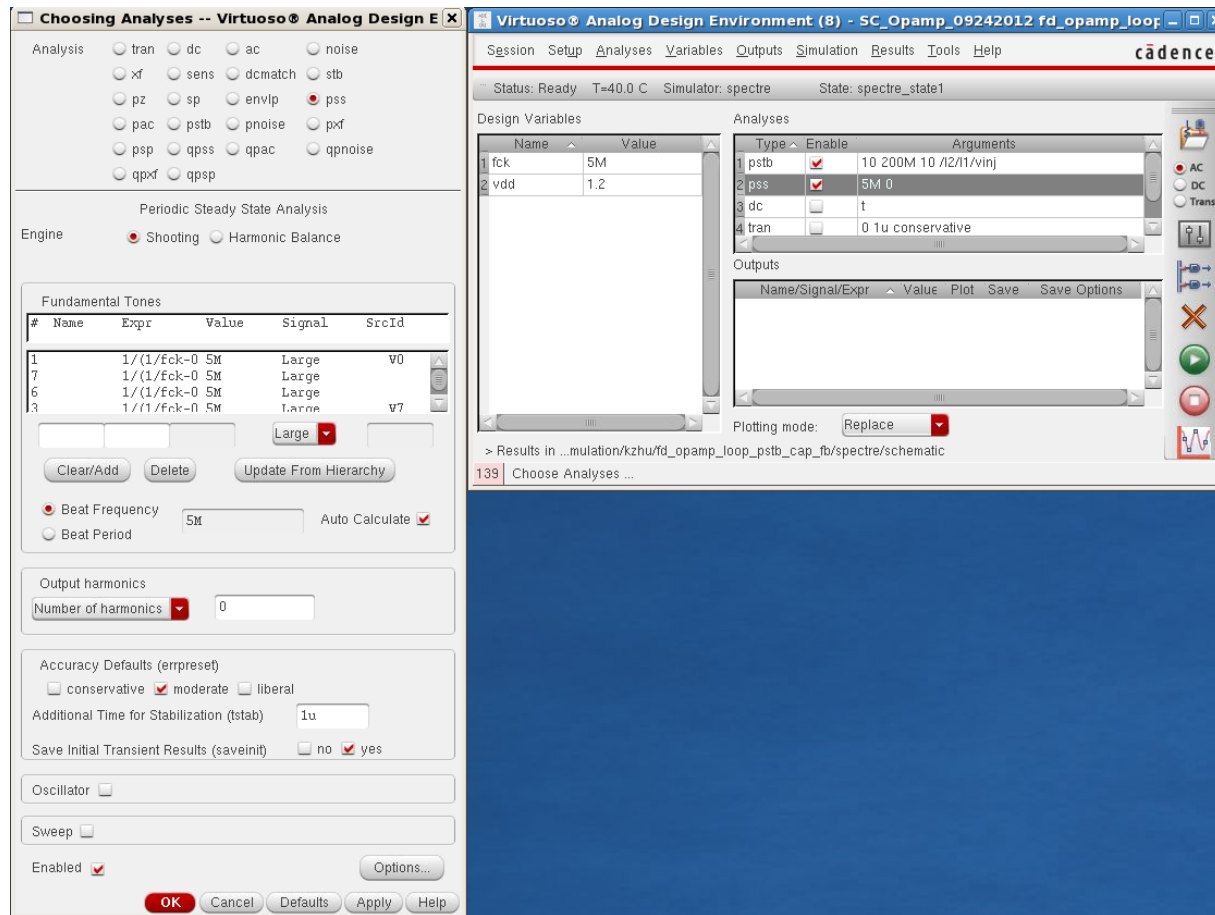


- ❑ Use FFT to interpret noise spectrum

Sampled Circuit Noise Analysis

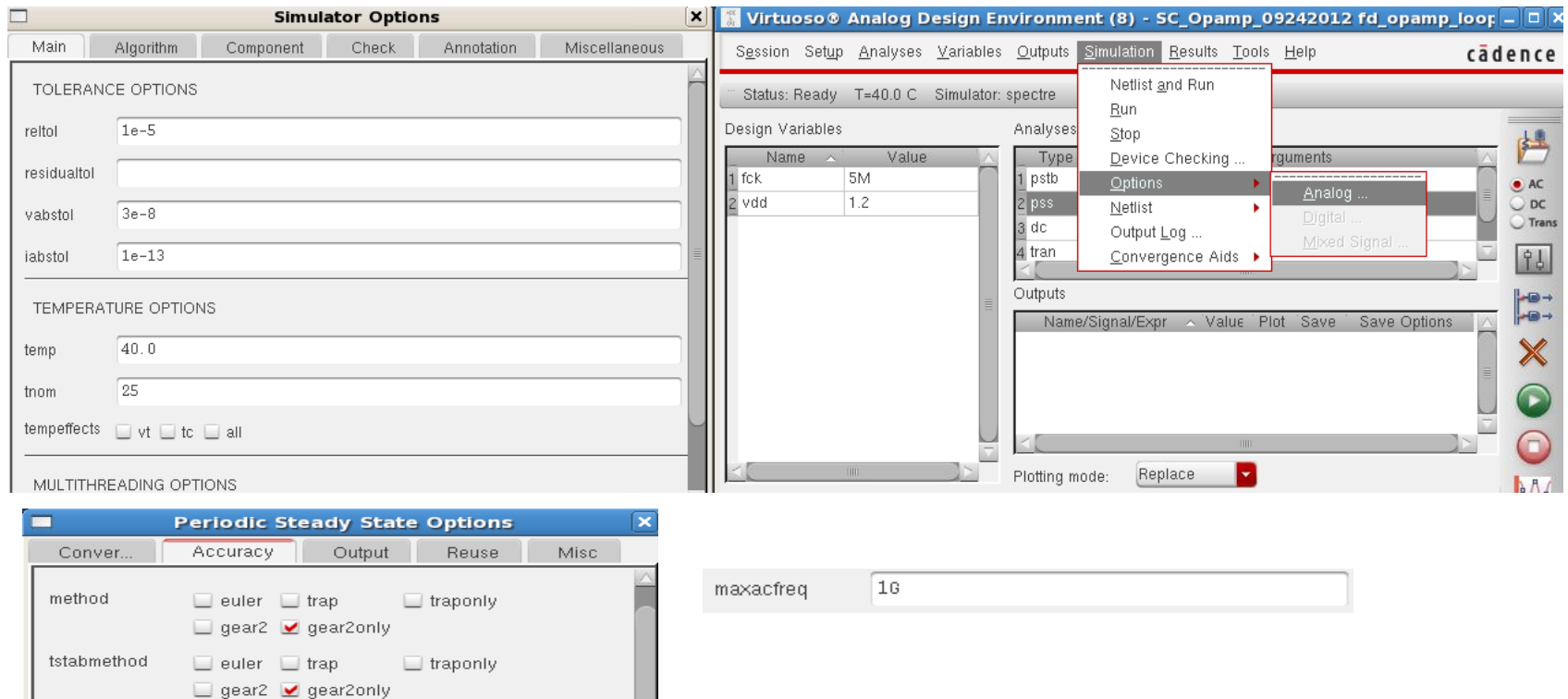
- ❑ Use .pnoise along with .pss analysis
 - Look at the Spectre PSS setup slides
- ❑ PNOISE analysis works similar to the .noise analysis for CT circuits
 - Same plotting and noise report forms as shown for .noise analysis

Simulation Setup---PSS



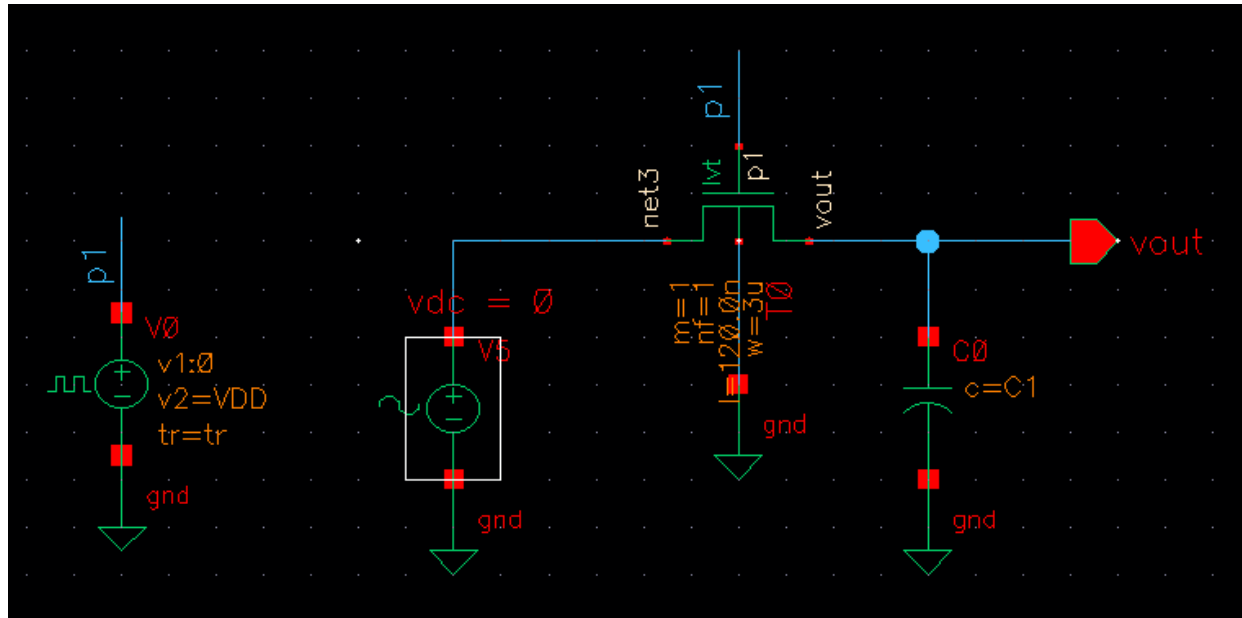
- ❑ We can only set the number of harmonics to 0 by choosing Shooting method
- ❑ tstab parameter can be obtained by tran analysis first

PSS Accuracy Suggestions



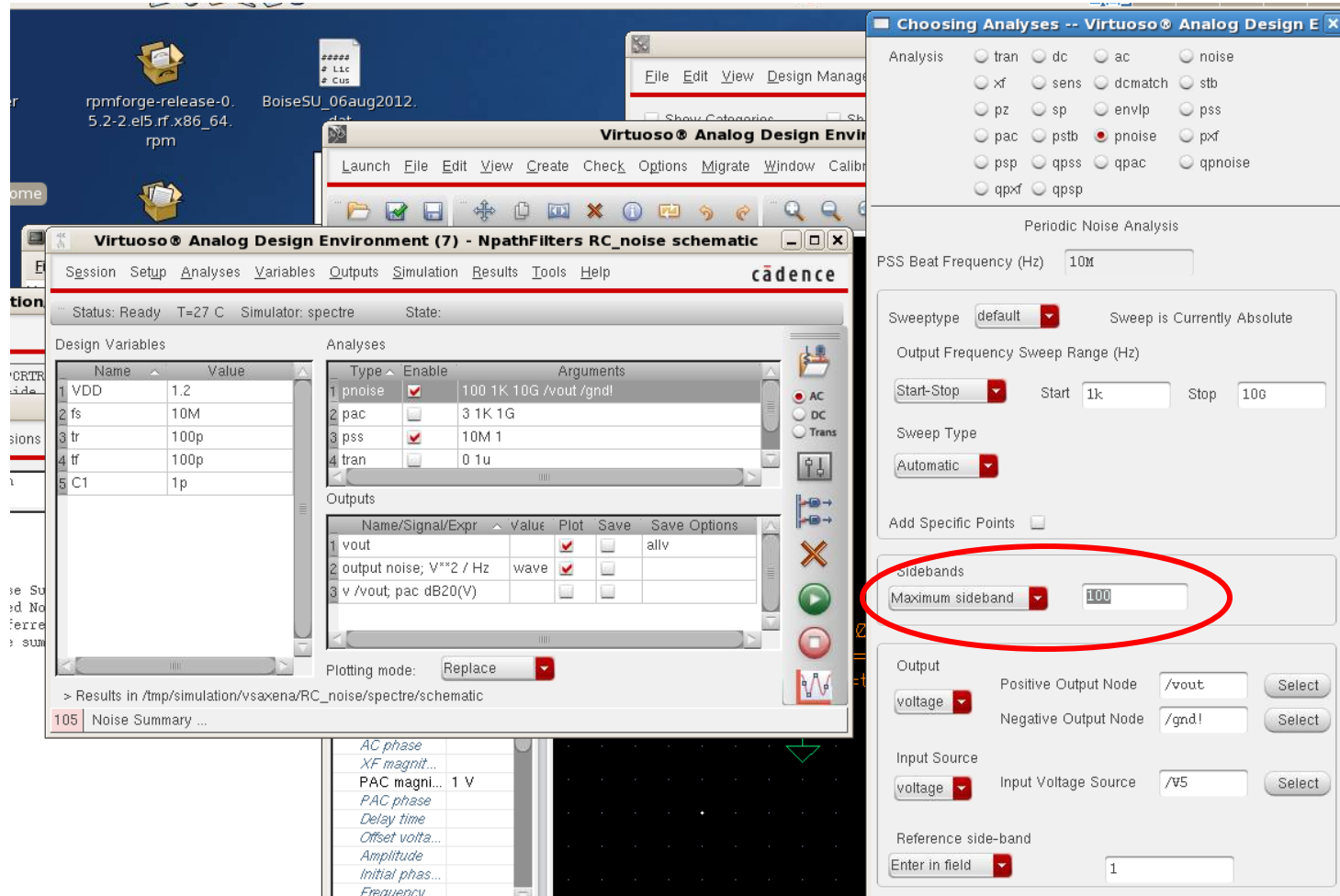
- ❑ Go to Simulation → Options → Analog → Main in the ADE window to setup tolerance options accordingly. If the frequency of periodic small signal analyses followed by PSS is high (e.g. 1G), the *maxacfreq* parameter (options → accuracy) of the PSS can be used to specify the highest frequency, otherwise, the frequency analysis in PAC maybe truncated.

PNOISE Analysis



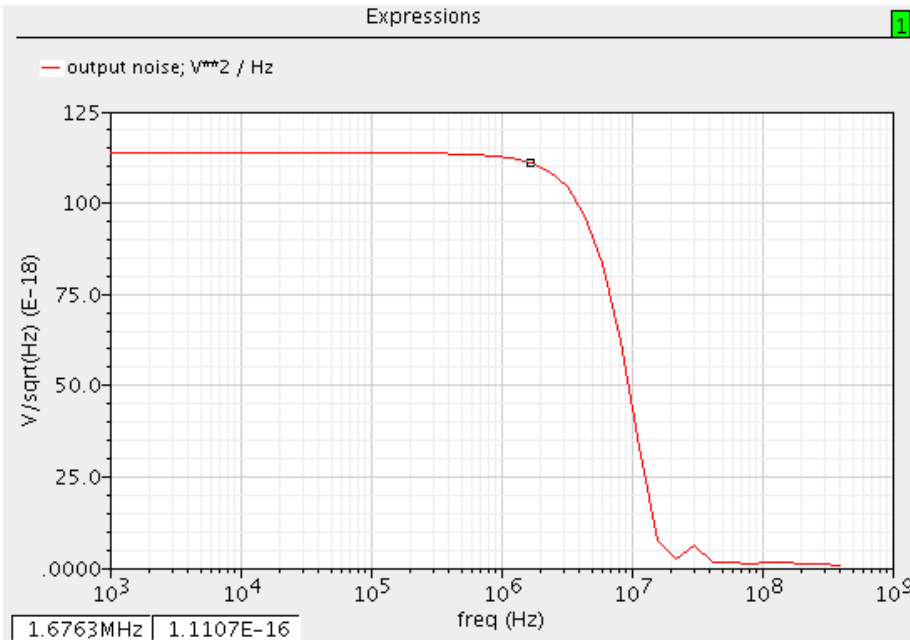
- ❑ Simulation of noise in sampled circuits
- ❑ Example: Switch-C circuit
 - Here an NMOS switch with $C=1\text{pF}$, $f_{\text{clk}}=10\text{MHz}$
- ❑ Set up PSS analysis for the $f_{\text{clk}}=10\text{MHz}$ clock

PNOISE Analysis



- ❑ Include sufficient number of *maxsideband* for accuracy

PNOISE Analysis



Results Display Window

Window Expressions Info Help

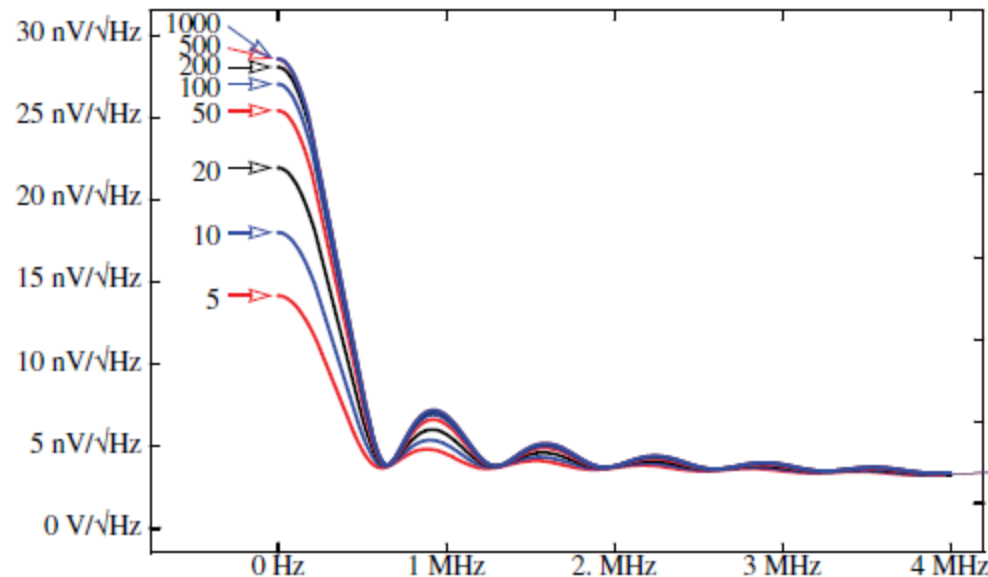
cadence

Device	Param	Noise Contribution	% Of Total
/T0	id	8.94286e-05	77.78
/T0	rd	3.38039e-05	11.11
/T0	rs	3.37969e-05	11.11

Integrated Noise Summary (in V) Sorted By Noise Contributors
Total Summarized Noise = 0.000101402
Total Input Referred Noise = 0.00037664
The above noise summary info is for pnoise data

- ❑ Simulation shows $89\mu\text{V}$ of output RMS noise
 - Ideal $\sqrt{(kT/C)}$ value = $64\mu\text{V}$,
 - Simulation results close to the approximation of $\sqrt{(kT/C)}$

PNOISE Analysis



- ❑ Accuracy is tightened by using large number of *maxsideband* parameter
 - Determines how many sideband alias into the given band
 - Trades-off simulation time with accuracy
- ❑ For analytical details, refer to:

<http://www.designers-guide.org/analysis/sc-filters.pdf>

References

1. Spectre User Simulation Guide
2. K. Kundert, "Simulating Switched-Capacitor Filters with SpectreRF," The Designer's Guide Community, www. <http://www.designers-guide.org/>, 2005.
<http://www.designers-guide.org/analysis/sc-filters.pdf>
3. K. Kundert, "An Introduction to Cyclostationary Noise," The Designer's Guide Community, www. <http://www.designers-guide.org/>, 2005.
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5. C.A. Gobet, "Spectral Distribution of a Sampled 1st-Order Lowpass Filtered White Noise," Electronics Letters, vol. 17, pp. 720-721, Sep. 1981.
6. C.A. Gobet, A. Knob, "Noise Analysis of Switched Capacitor Networks," IEEE Trans. Circuits and Systems, vol. cas-30, pp. 37-43, Jan. 1983.
7. J.H. Fischer, "Noise Sources and Calculation Techniques for Switched Capacitor Filters," IEEE J. Solid-State Circuits, vol. sc-17, pp. 742-752, Aug. 1982.