VCO Simulation with Cadence Spectre

Kehan Zhu, Vishal Saxena

AMS Lab, Boise State University

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- VCO voltage tuning range
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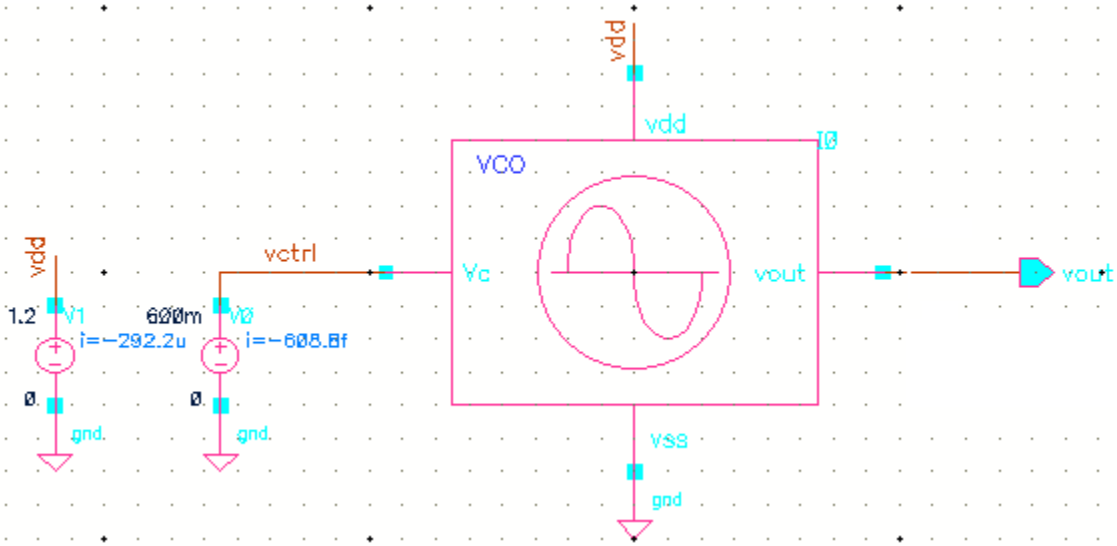
- Phase noise



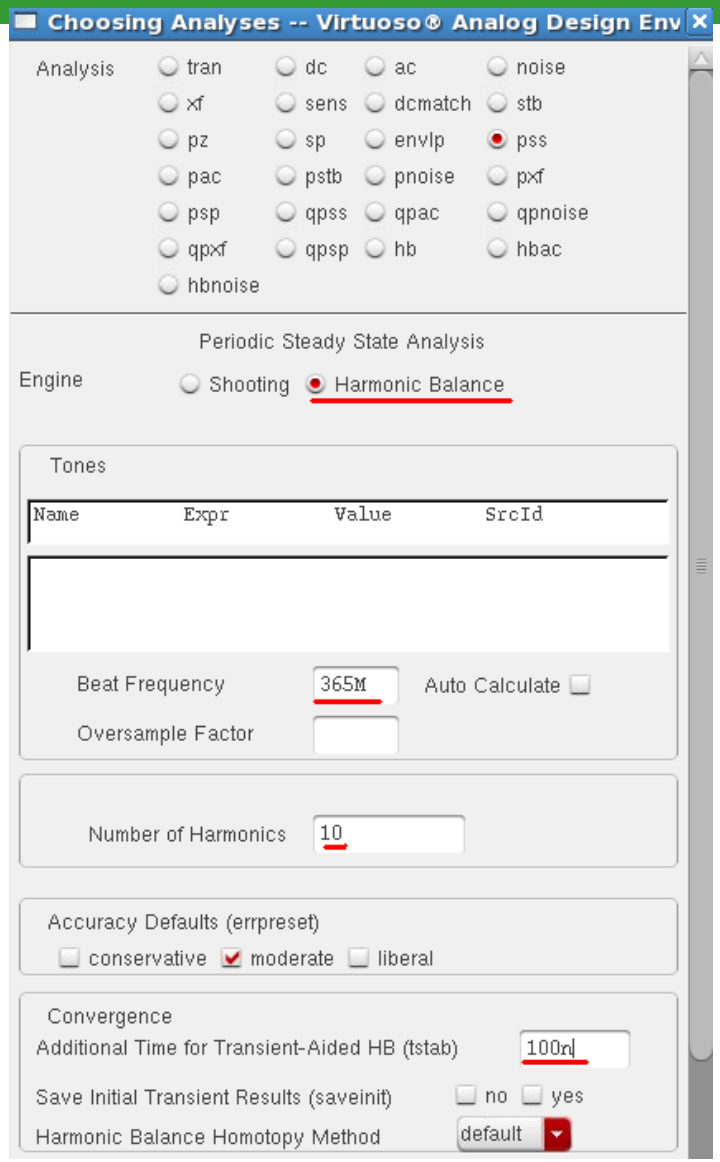
Note: the simulation results shown are not optimized, and provided only for simulation guidance purpose.

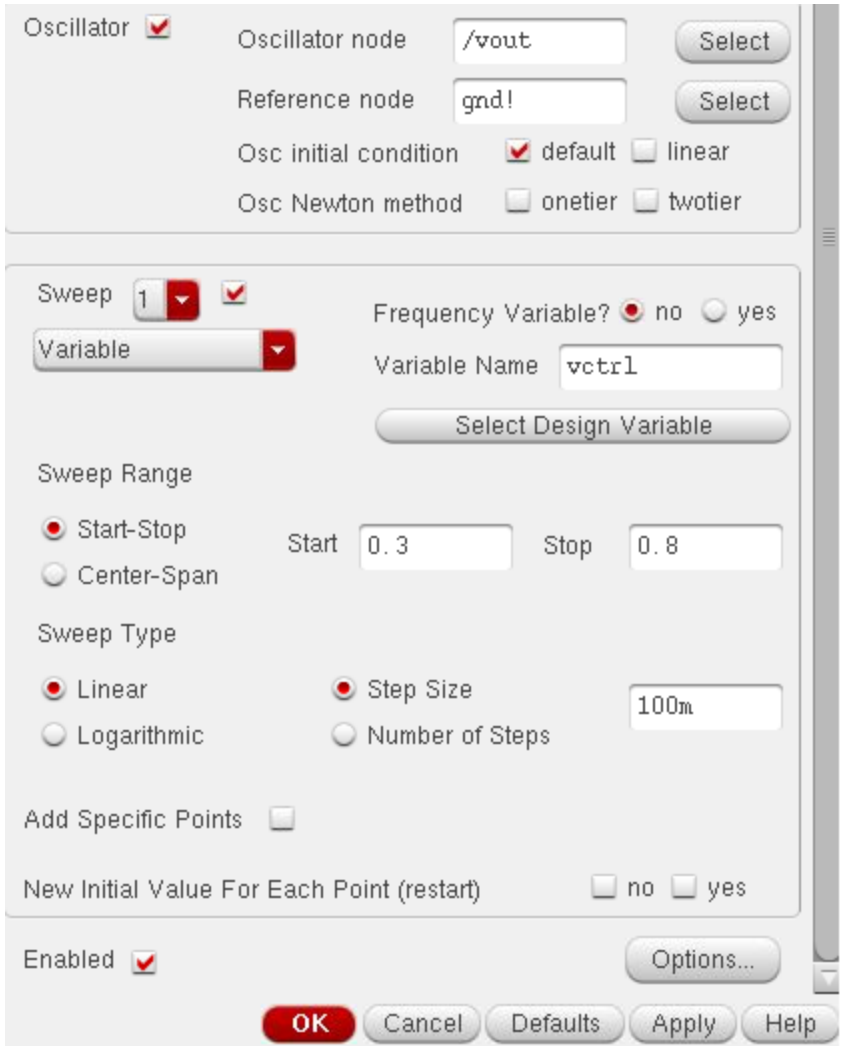
K_{VCO} simulation

PSS (Periodic Steady State) Analysis

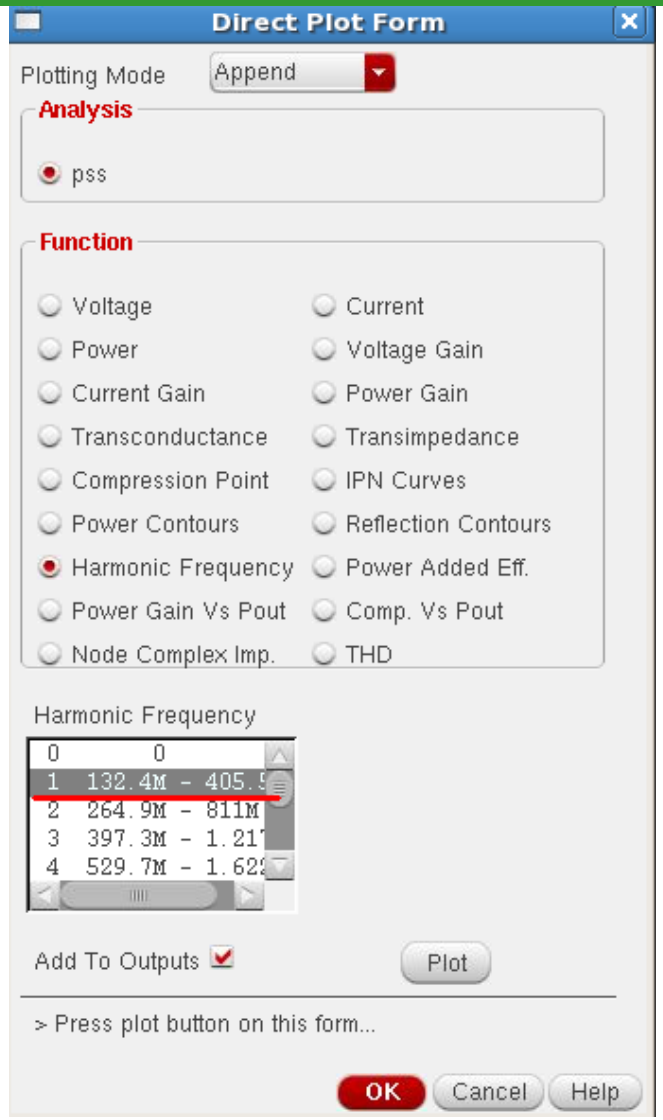
- Any Verilog-A models are not allowed in the simulation bench, PSS does not support Verilog-A.
- Do .tran analysis first to estimate the VCO frequency at the fixed Vctrl as the Beat frequency.
- Make sure the VCO works by setting the “Initial Condition”, “tstab” should be longer than the time the VCO needs to stable.
- If the VCO frequency is off the beat frequency by too much over sweeping Vctrl, PSS may fail. So confine the Vctrl to a reasonable range.
- After finishing simulation, go to ADE Results->Direct Plot->Main Form…open the Direct Plot Form, see later

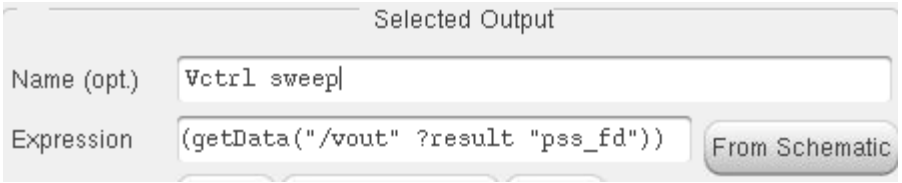
PSS setup

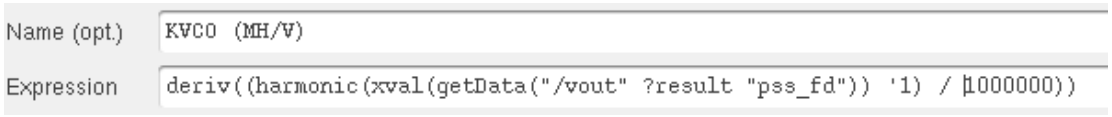

Choosing Analyses -- Virtuoso® Analog Design Env
Analysis
tran
dc
ac
noise
xf
sens
dcmatch
stb
pz
sp
envlp
pss
pac
pstb
pnoise
pxf
psp
qpss
qpac
qpnoise
qpxf
qpsp
hb
hbac
hbnoise
Periodic Steady State Analysis
Engine
Shooting
Harmonic Balance
Tones
Name
Expr
Value
SrcId
Beat Frequency
365M
Auto Calculate
Oversample Factor
Number of Harmonics
10
Accuracy Defaults (errpreset)
conservative
moderate
liberal
Convergence
Additional Time for Transient-Aided HB (tstab)
100n
Save Initial Transient Results (saveinit)
no
yes
Harmonic Balance Homotopy Method
default


Oscillator
Oscillator node
/vout
Select
Reference node
gnd!
Select
Osc initial condition
default
linear
Osc Newton method
onetier
twotier
Sweep
1
Variable
Frequency Variable?
no
yes
Variable Name
vctrl
Select Design Variable
Sweep Range
Start-Stop
Center-Span
Start
0.3
Stop
0.8
Sweep Type
Linear
Logarithmic
Step Size
Number of Steps
100m
Add Specific Points
New Initial Value For Each Point (restart)
no
yes
Enabled
Options...
OK
Cancel
Defaults
Apply
Help

PSS Plotting

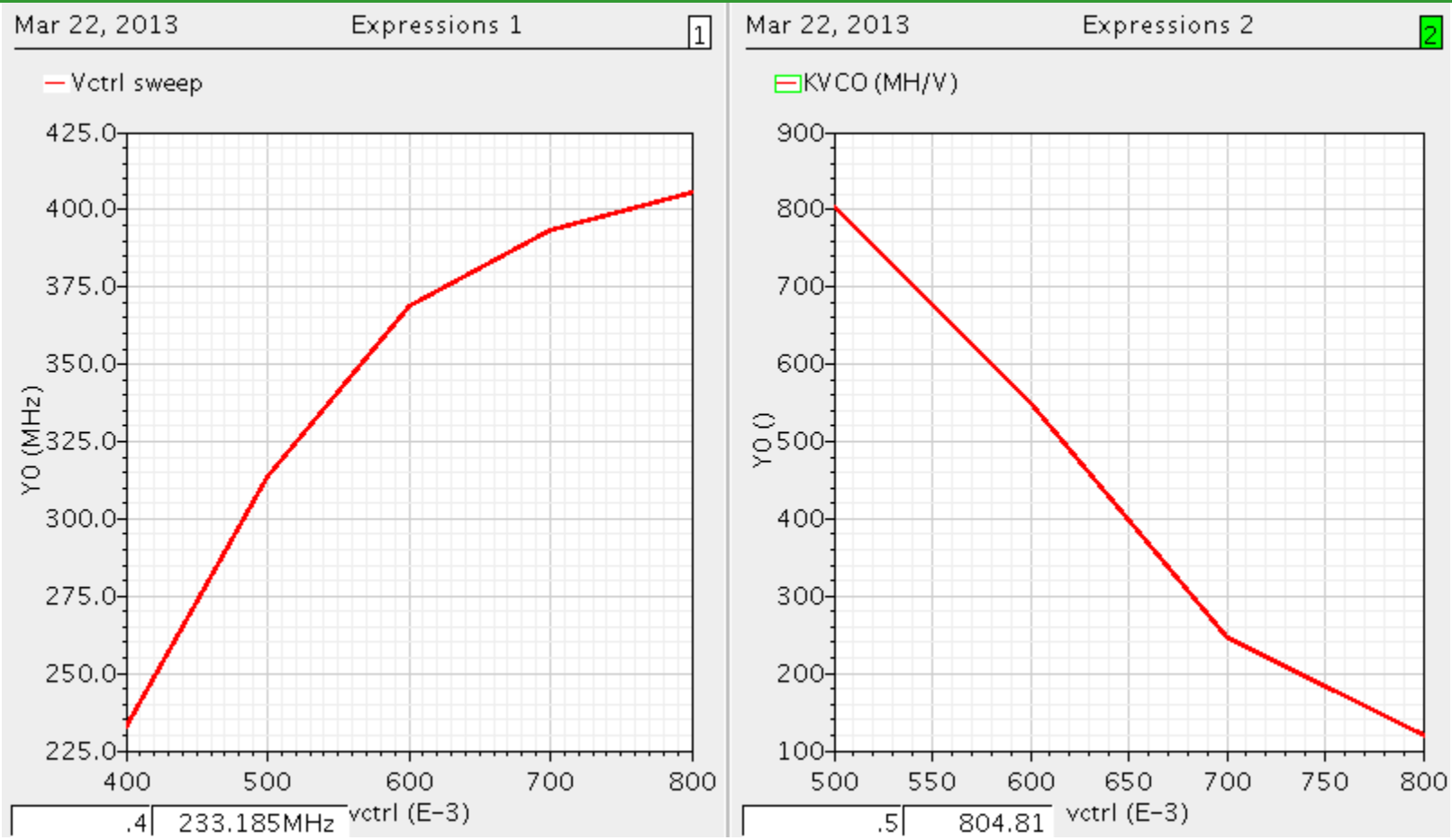






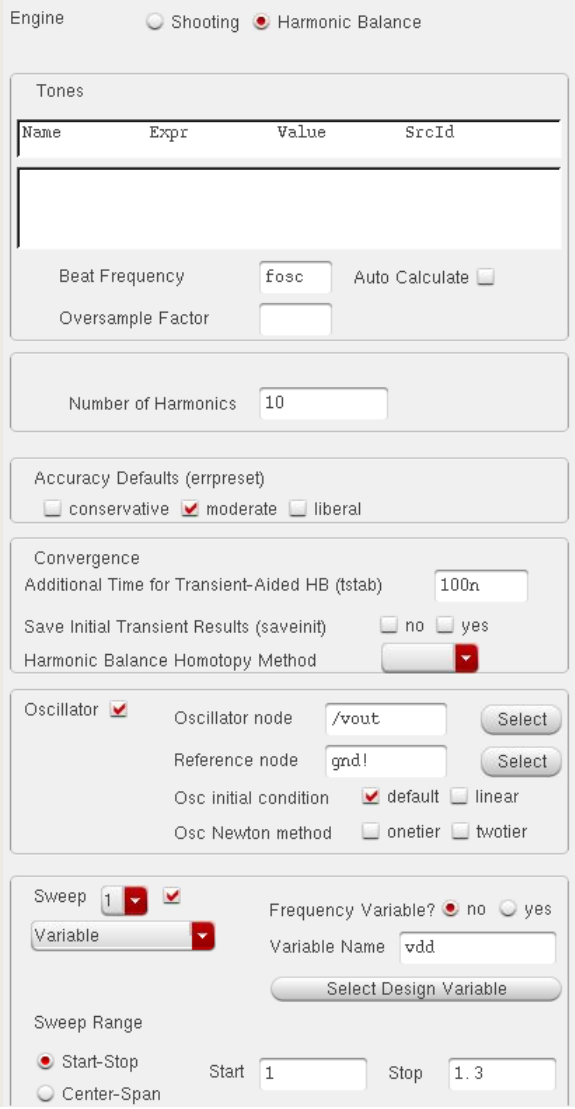
Choose the fundamental frequency to plot
Also, you can use calculator setting the outputs as above to get the KVCO plot, see next.

PSS simulation plots

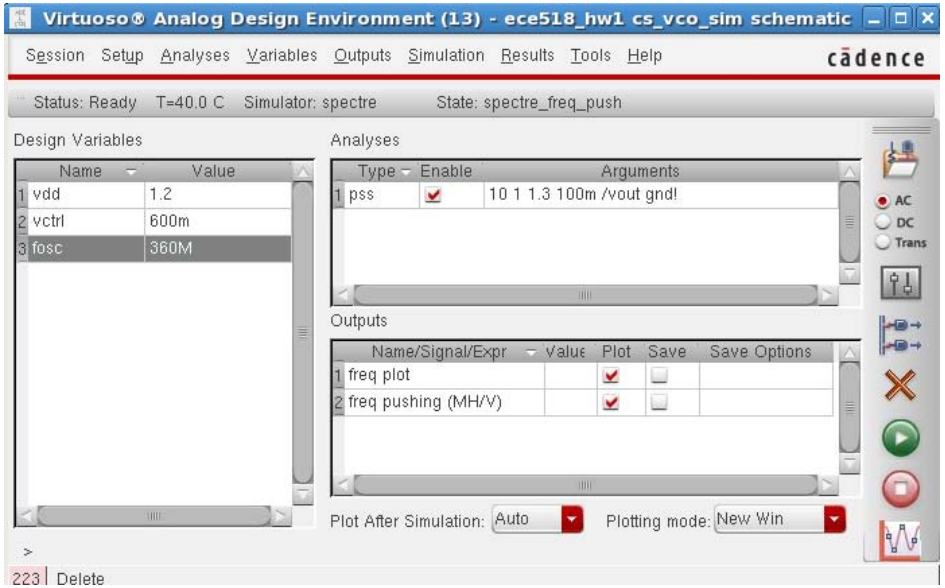


VCO frequency and KVCO versus Vctrl are plotted.

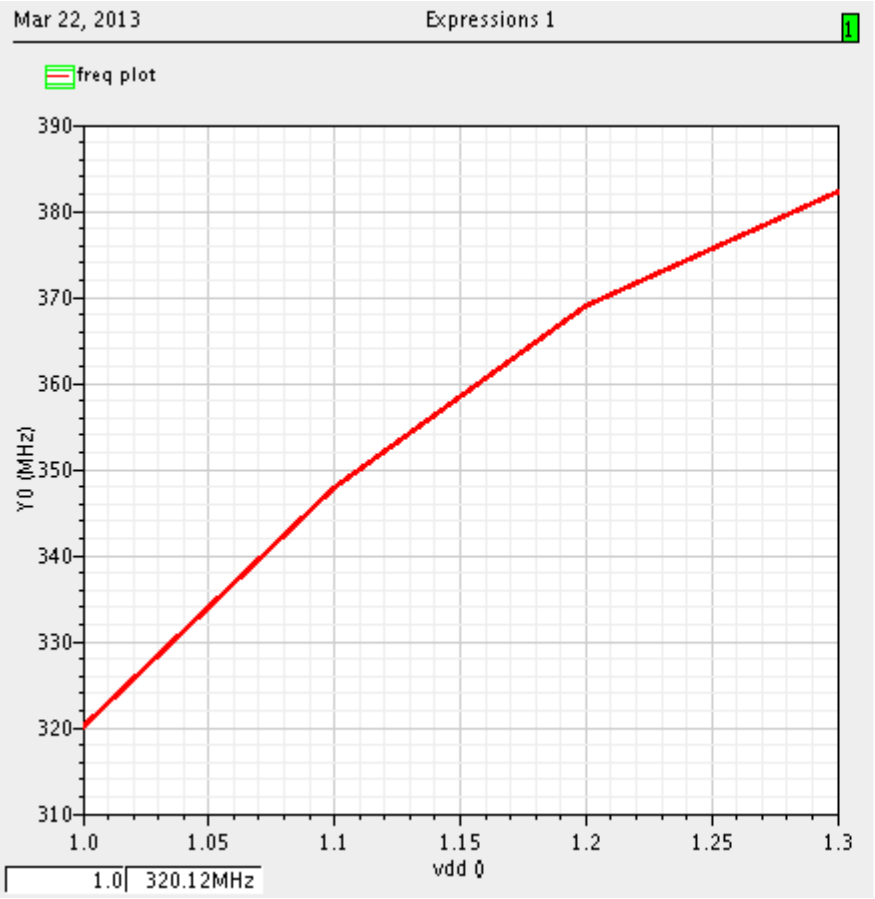
Frequency Pushing

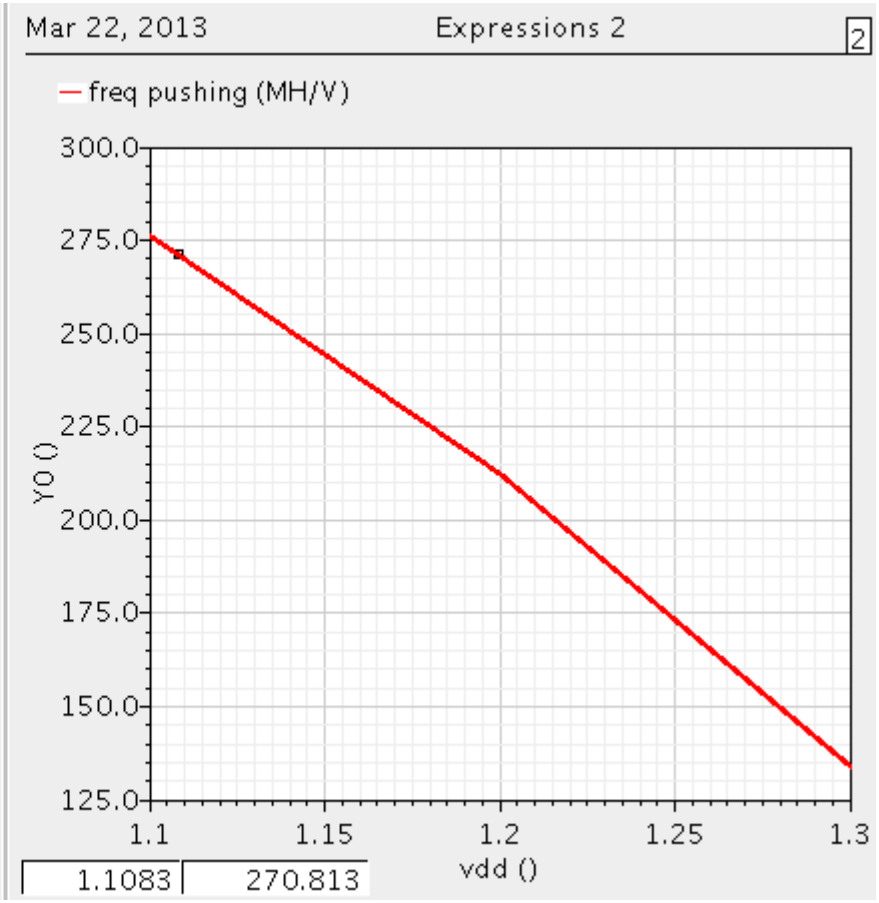


To test the VCO frequency changing with power supply voltage variations, in the same manner as before, just change the sweeping variable to “vdd”.
Notice here beat frequency is defined as a variable for easy change at the ADE.

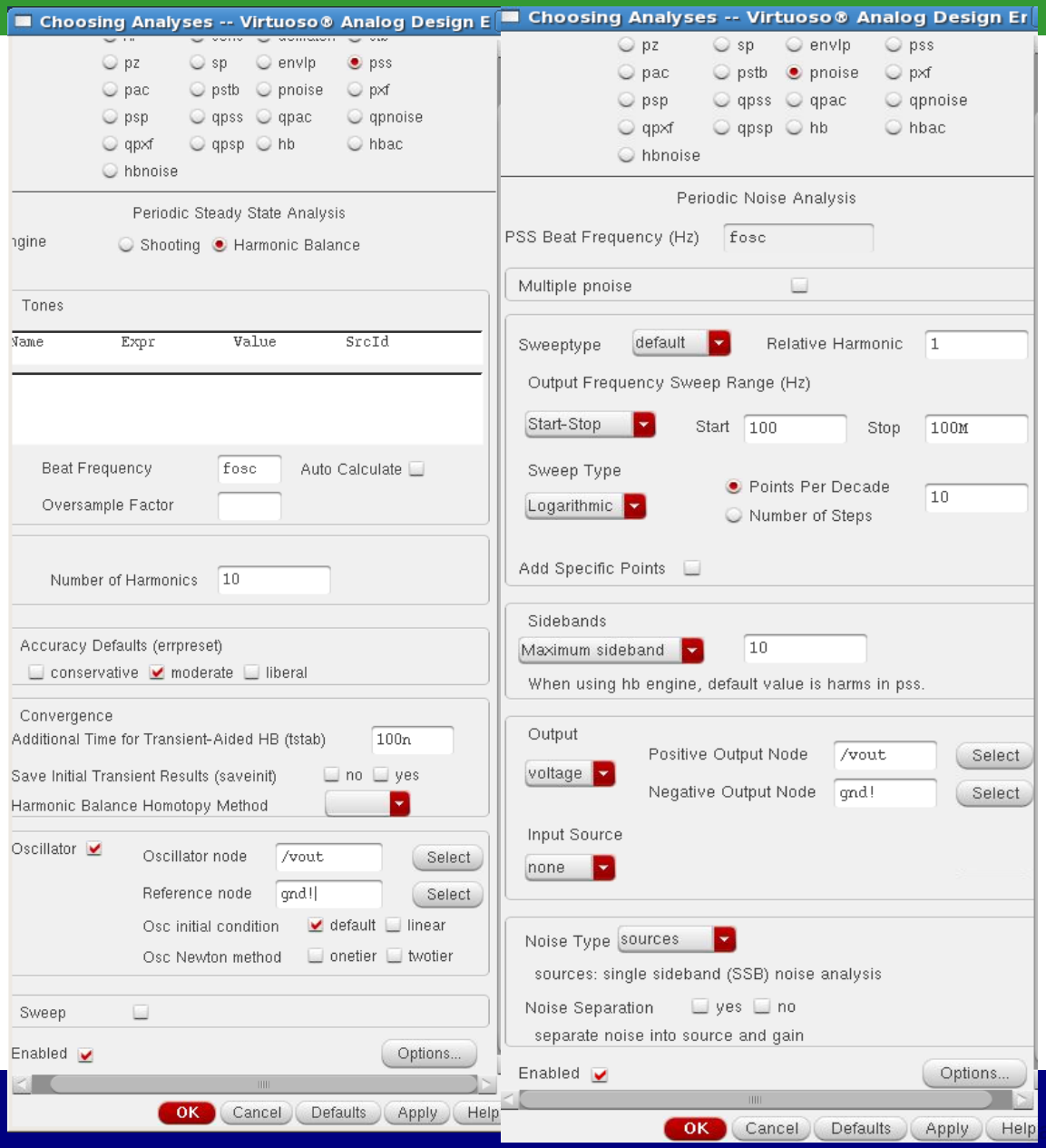


PSS simulation plots





Phase noise



Setup PSS first, then Pnoise

Pnoise Simulation Result