



Tutorial on getting started in Cadence

Advanced Analog Circuits

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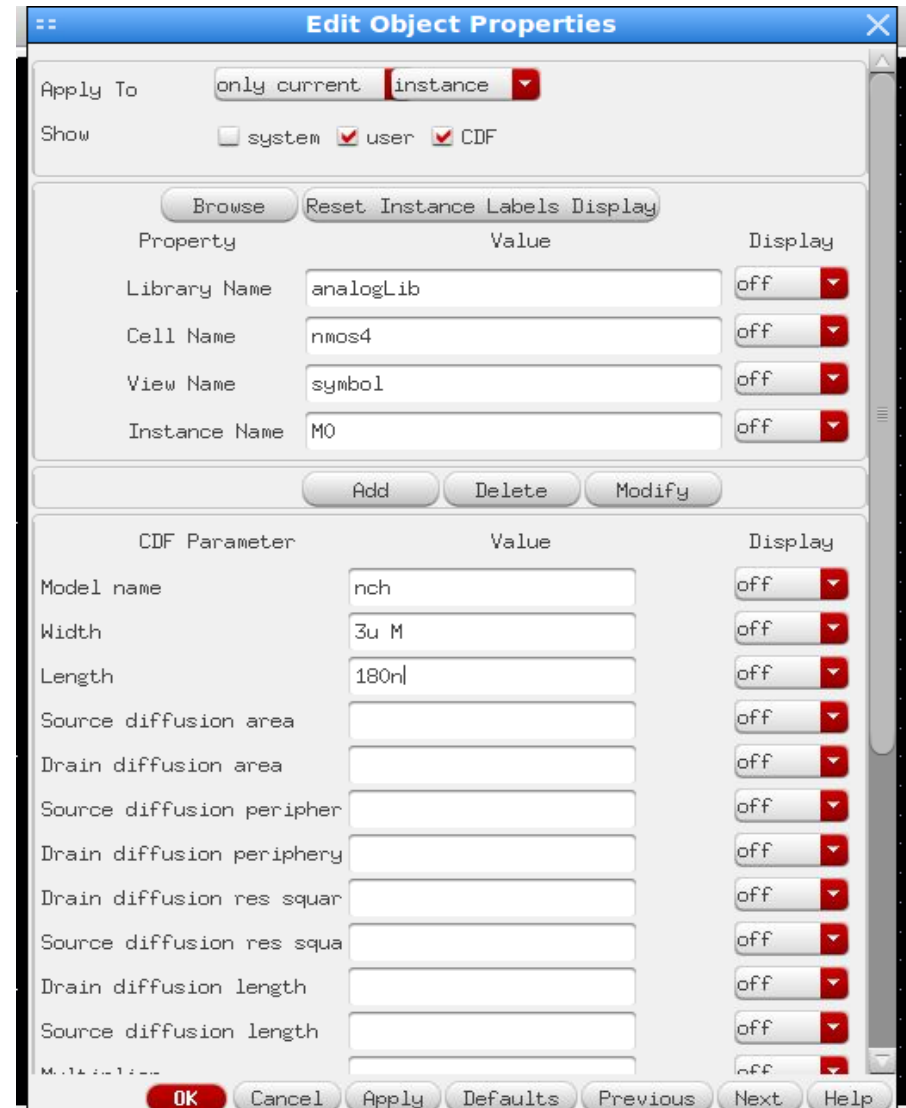
Getting Started

- Start Cadence from the terminal by using the command *virtuoso*
- Click Tools--->Library Manager.
- Click File ---> New ---> Library .
- Name your library *Homework1*. You do not need any process information attached to the library.
- In the library manager, select the library you just created and click File ---> New ---> Cellview .
- Enter the cellname. For example, we will now create a testbench for DC characterization of the transistor, 'transistor_dcchar_tb' . Make sure that the library name should be same is correct, the view name should be "schematic" and type is "composer-schematic".



Creating schematics

- In the new schematic composer window, we will place the nmos. In the top menu, Create -> Instance , or just press 'i' from the keyboard,. Click "Browse" next to library name to open the Library browser. Choose "analogLib" for library , "nmos4" for the cell and "symbol" for the view.
- The model name is "nch". Do NOT include the library name in this line.
- Enter the parameters of the nmos, here we have a width of 3um and length 180 nm.



Apply To: instance

Show: system user CDF

Property	Value	Display
Library Name	analogLib	off
Cell Name	nmos4	off
View Name	symbol	off
Instance Name	M0	off

CDF Parameter	Value	Display
Model name	nch	off
Width	3u M	off
Length	180n	off
Source diffusion area		off
Drain diffusion area		off
Source diffusion peripher		off
Drain diffusion periphery		off
Drain diffusion res squar		off
Source diffusion res squa		off
Drain diffusion length		off
Source diffusion length		off
M...		off



Creating schematics

- Similarly, from analogLib you can instantiate voltage sources using the "vdc" component.
- Note that we have entered a variable name "Vds" for the DC voltage value. This is because we will be doing a DC sweep for the drain and gate voltages as we characterize the device.
- Instantiate another voltage source with voltage "Vgs".
- Instantiate a ground node using the "gnd" cell from analogLib.
- Although, we don't need them for this example, you can instantiate capacitors using "cap", resistors with "res" and inductors with "ind".

Add Instance

Library: analogLib

Cell: vdc

View: symbol

Names:

Array: Rows: 1 Columns: 1

Noise file name:

Number of noise/freq pair: 0

DC voltage: **Vds**

AC magnitude:

AC phase:

XF magnitude:

PAC magnitude:

PAC phase:

Temperature coefficient:

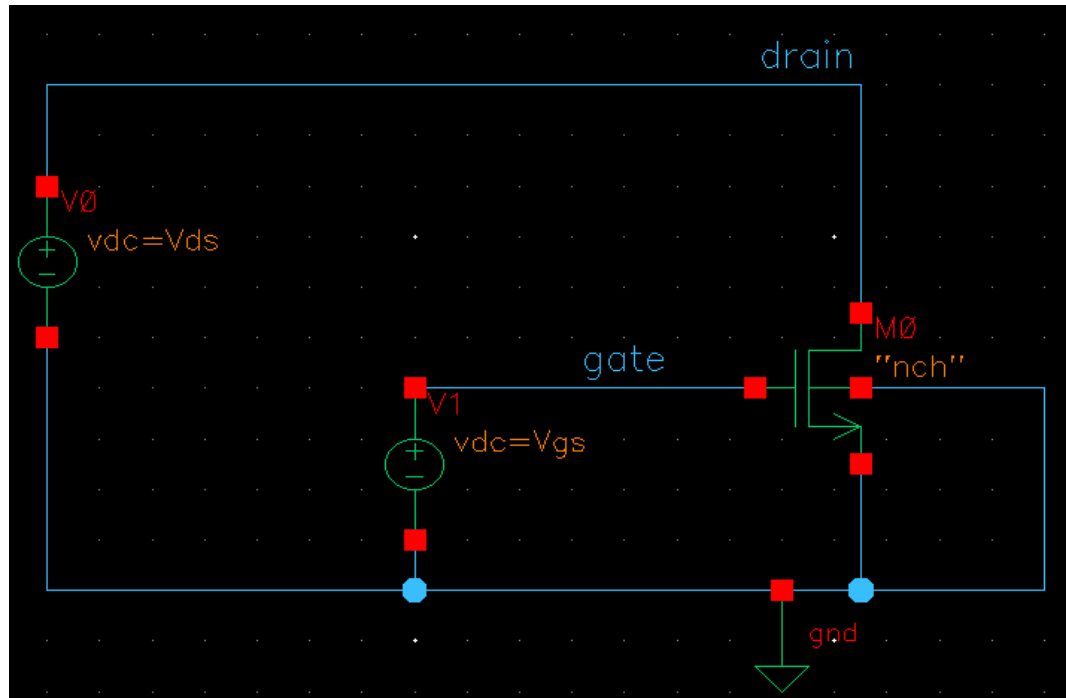
Temperature coefficient:

Nominal temperature:



Creating schematics

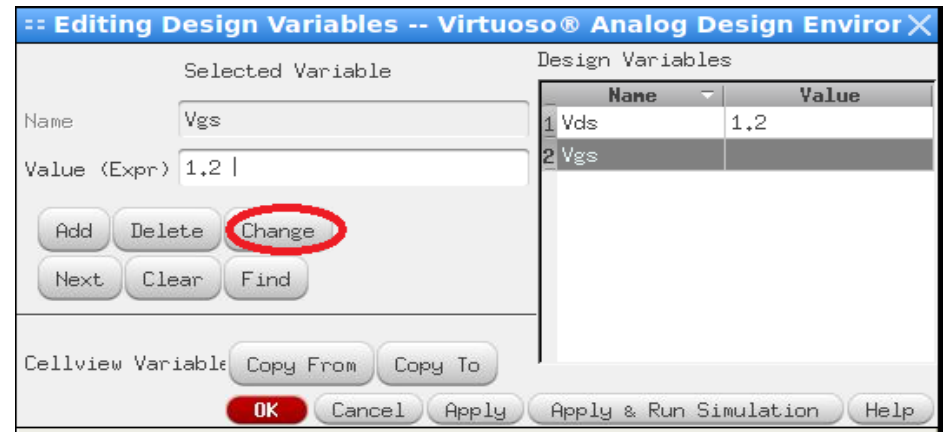
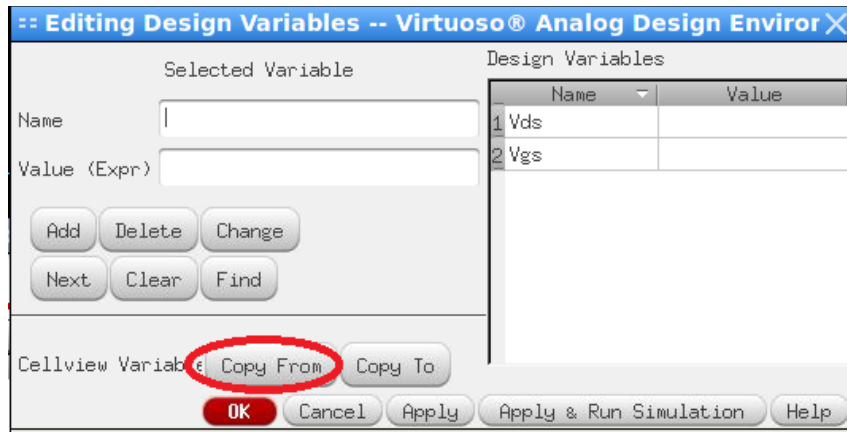
- Once all the components are instantiated, connect them appropriately, using the Create-> Wire command from the top menu in the schematic composer window. You can also just press 'w' .
- You can label the wires by pressing 'l' key. (This is the small l for lamb). Enter the name and drag and place it on the desired net.
- Your schematic should now look like
- Save your schematic from the top menu in the schematic composer window by clicking File-> Check and Save.





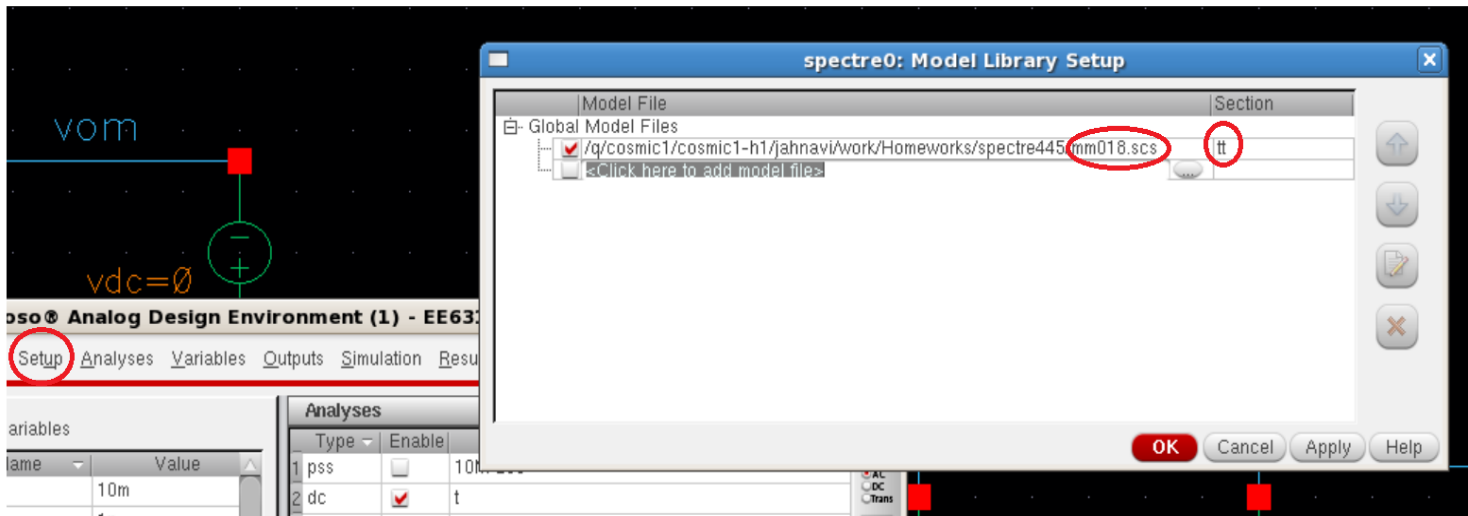
Running a simulation: Variables

- From the top menu in the schematic composer, select Launch->ADE L.
- First we will assign nominal values to the variables in our schematic. For this, in the ADE window, select Variables -> Edit. As you can typically have a lot of variables, and don't accidentally want to miss adding any of them, click on the "Copy From" button. This carries over all the variables in the schematic to your ADE window.
- Now click on a variable and change it's value. For this, click on the variable, enter the desired value and click "Change". I have nominally assigned them both to 1.2 V but we will be sweeping these variables.



Running a simulation: Model Library

- The library name should be instantiated from ADE-L through the Setup/Model library menu. Use the 'tt' process corner for homeworks.



- Other devices, can be instantiated by using the appropriate sections as listed in the following table:

Device	Model name	Section
1.8V pMOS, nMOS regular devices	nch, pch	tt
3.3V pMOS, nMOS regular devices	nch3, pch3	tt_3v
1.8V zero Vt nMOS	nanch	tt_na
3.3V zero Vt nMOS	nanch3	tt_3vna
1.8V medium Vt nMOS	mench	tt_m
3.3V medium Vt nMOS	mench3	tt_3m



Running a simulation: Saving currents

- By default, Spectre only saves the currents flowing through voltage sources.
- To monitor the current in a branch add a 0 V voltage source (“vdc” component) in that branch.
- You can also ask Spectre to save all the currents from the ADE-L menu by selecting Outputs-> Save all and then checking Select Device Currents -> all.
- If you have a very large schematic saving all the currents can take up too much disk space during simulation.

The screenshot shows the 'Save Options' dialog box with the following settings:

- Select signals to output (save): none selected lvlpub lvl allpub all
- Select power signals to output (pwr): none total devices subckts all
- Set level of subcircuit to output (nest): [Empty text box]
- Select device currents (currents): selected nonlinear all
- Set subcircuit probe level (subcktprobe): [Empty text box]
- Select AC terminal currents (useprobes): yes no
- Select AHDL variables (saveahdlvars): selected all
- Save model parameters info:
- Save elements info:
- Save output parameters info:
- Save primitives parameters info:
- Save subckt parameters info:
- Save asserts info:
- Output Format: sst2 psf psf with floats psfx1
- Use Fast Viewing Extensions:

Buttons at the bottom: OK, Cancel, Defaults, Apply, Help



Running a simulation: DC Sweep analysis



Now let us setup a simulation. We will sweep the drain voltage for a fixed gate voltage. Then we will sweep the gate voltage as well.

Essentially, we want to generate the device I-V characteristics for different gate and drain voltages.

- In the ADE window , click Choose -> Analysis.
- Configure your window as shown below to perform a DC sweep. We will sweep drain voltage V_{ds} for a fixed gate voltage V_{gs} of 1.2 V.

(a) Check "Save DC Operating Point"

(b) Check "Design Variable" and from the "Select Design Variable" menu choose " V_{ds} ".

(c) In the "Sweep Range", sweep from 0 to 1.2 V. In "Sweep Type", choose "Linear" and enter a "Step Size" of 0.1 V. Note that sometimes you may want to choose "Logarithmic" when you are sweeping over very large ranges.

Click "OK".

- Now we can run the analysis. From the ADE window choose Simulation -> Netlist and Run. A simulation log should open up where you will see the simulations running.

Choosing Analyses -- Virtuoso® Analog Design Environm X

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

DC Analysis

Save DC Operating Point
Hysteresis Sweep

Sweep Variable

Temperature
 Design Variable Variable Name
 Component Parameter
 Model Parameter

Sweep Range

Start-Stop Start Stop
 Center-Span

Sweep Type

Step Size
 Number of Steps

Add Specific Point

Enabled



Running a simulation: Results from swept DC analysis

To plot the results from your sweep analysis, from the ADE-L window select Tools-> Calculator.


In the calculator window, select "is" and click on the negative terminal of the DC voltage source (instance name "V0" in this example)at the drain node. The entry IS("/V0/MINUS") should appear as shown below in the calculator window.

Click the plot button circled in the picture. This will plot the DC current from the swept analysis.

File Tools View Options Constants Help cadence

Results Dir: /q/cosmic5/cosmic5-h1/ritesh/simulation/transistor_dcchar_tb/spectre/schematic/psf

vt vf vdc vs op var vn sp vswr hp zm
 it if idc is opt mp vn2 zp yp gd data

Off Family Wave Clip 

IS("/V0/MINUS")

Special Functions

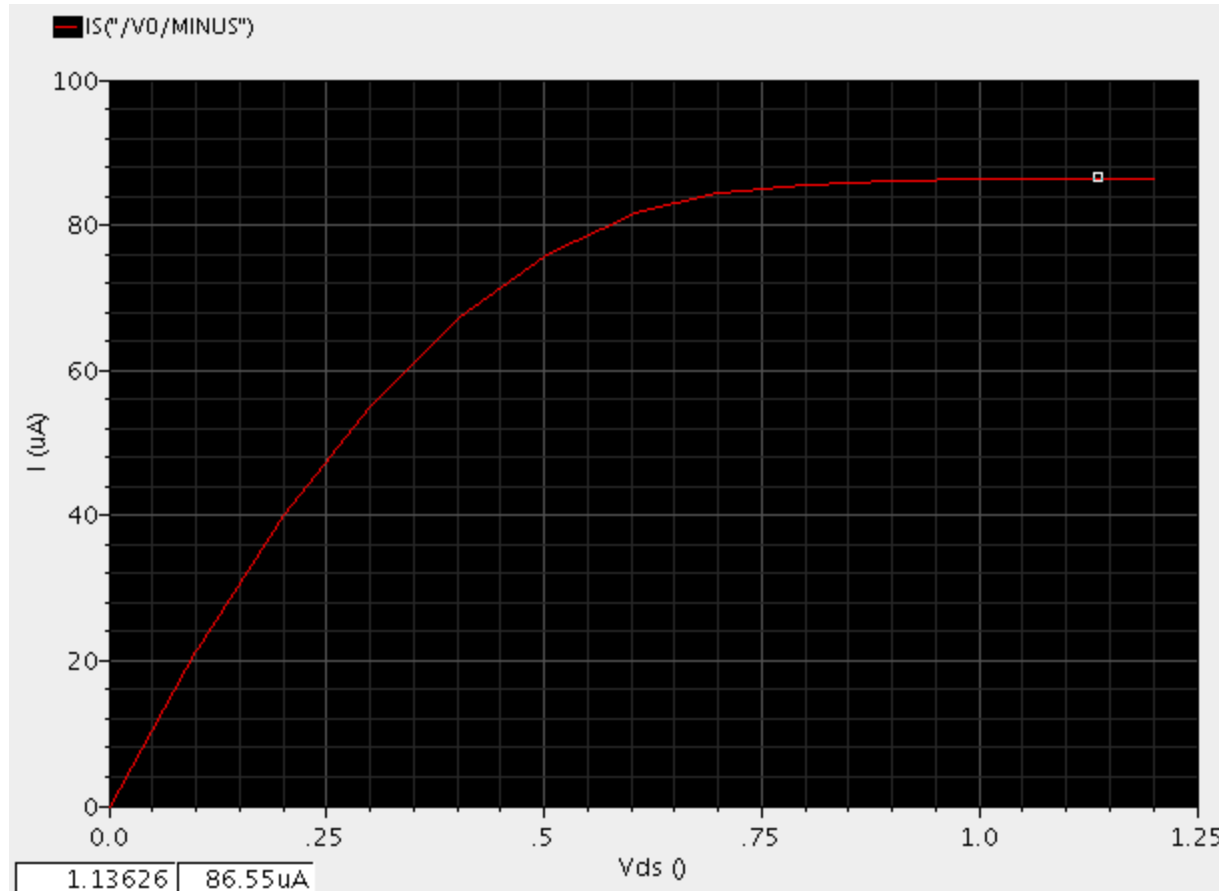
a2d	cross	dutyCycle	freq_jitter	histo	overshoot	psddb	sample	thd
average	d2a	evmQAM	frequency	iinteg	peak	pzbode	settlingTime	unityGainFreq
bandwidth	dBm	evmQpsk	gainBwProd	integ	peakToPeak	pzfilter	slewRate	value
clip	delay	eyeDiagram	gainMargin	intersect	period_jitter	riseTime	spectralPower	xmax
compare	deriv	fallTime	getAsciiWave	ipn	phaseMargin	rms	spectrum	xmin
compression	dft	flip	groupDelay	ipnVRI	phaseNoise	rmsNoise	spectrumMeas	xval
compressionVRI	dftbb	fourEval	harmonic	loadpull	pow	root	stddev	ymin
convolve	dnl	freq	harmonicFreq	lshift	psd	rshift	tangent	ymin

Successful evaluation

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Running a simulation: Results from swept DC analysis





Running a simulation: Parametric analysis

- For homework 1 you will need to run this DC sweep with a parametric sweep on the variable "Vgs" . This enables you to sweep "Vds" through the DC sweep analysis we just set up for different gate voltages. This way you can generate, for example, Ids vs Vds for different Vgs.
- From the ADE menu, choose Tools -> Parametric Analysis.
- In the parametric analysis window, click on "Choose Variable" and select Vgs and enter the sweep ranges as shown below. Check "Sweep", enter the "From" and "To" values. Finally, select the "Step Mode" as "Linear" and enter the "Step Size" of 0.1 V.
- Select Analysis -> "Start Selected Sweep".
- This will now perform the DC sweep discussed previously for each Vgs value.

Variable	Value	Sweep?	Range Type	Start Point	End Point	Step Mode	Step Value	Inclusion List	Exclusion List
Add Variable...		<input checked="" type="checkbox"/>	From/To			Auto			



Running a simulation: Results from parametric swept DC analysis



To plot the results from your parametric sweep analysis, follow the same steps as those for plotting the results from the swept DC analysis.

You can plot the results in a new graph window by selecting New Window from the drop-down menu in the Calculator window

Virtuoso (R) Visualization & Analysis XL calculator

File Tools View Options Constants Help

Results Dir: /q/cosmic5/cosmic5-h1/ritesh/simulation/transistor_dcchar_tb/spectre/schematic/psf

vt vf vdc vs op var vn sp vswr hp zm
 it if idc is opt mp vn2 zp yp gd data

Off Family Wave Clip New Window

IS("/VO/MINUS")

Special Functions

a2d	cross	dutyCycle	freq_jitter	histo	overshoot	psdbb	sample	thd
average	d2a	evmQAM	frequency	iinteg	peak	pzbode	settlingTime	unityGainFreq
bandwidth	dBm	evmQpsk	gainBwProd	integ	peakToPeak	pzfilter	slewRate	value
clip	delay	eyeDiagram	gainMargin	intersect	period_jitter	riseTime	spectralPower	xmax
compare	deriv	fallTime	getAsciiWave	ipn	phaseMargin	rms	spectrum	xmin
compression	dft	flip	groupDelay	ipnVRI	phaseNoise	rmsNoise	spectrumMeas	xval
compressionVRI	dftbb	fourEval	harmonic	loadpull	pow	root	stddev	ymax
convolve	dnl	freq	harmonicFreq	lshift	psd	rshift	tangent	ymin

Successful evaluation

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Running a simulation: Results from parametric swept DC analysis

