# **Simulation with Cadence Analog Design Environment**

Analog Design Environment (ADE) is integrated on Cadence Custom IC Design software. You can simulate your design (schematic, extracted layout, vhdl, etc.) using the ADE.

This tutorial explains necessary steps required in preparing your design and using ADE to simulate the circuit. The tutorial assumes that you have the inverter cell with schematic and symbol views created as described in "Virtuoso Schematic Composer Tutorial" (available on class website).

### **Simulation Cell View Preparation**

The first step is to prepare the simulation schematic view. In this tutorial, we will simulate the inverter using pulse voltage source connected at its input. First, create new schematic view by go to File -> New -> Cell View, we will call this cell inverter\_sim as shown in Figure 1.

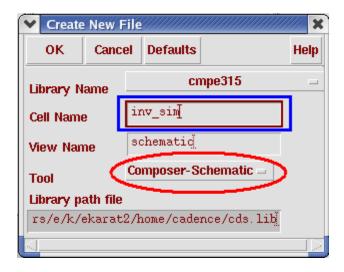


Figure 1: New simulation cell view

Next, we need to place the symbol of inverter on the schematic. Create new instance of the inverter by select "inv" from "cmpe315" library from the component browser as shown in Figure 2. At the Add Instance dialog, make sure you have **symbol** selected as shown in Figure 3, if not you can manually type in or click Browse.

Create instances of vdd, gnd, vdc and vpulse, create new OUTPUT pin (with "output" direction) and then make appropriate connections as shown in Figure 4. You can find vdc and vpulse from Voltage\_Sources -> vdc, Voltage\_Sources -> vpulse in NCSU\_Analog\_Parts library.

### Simulation with Analog Design Environment Tutorial



Figure 2: Select inv (inverter) cell from Component Browser

💙 Add I	nstance			C.
Hide	Cancel	Defaults	Help	
Library	cmpe315		Browse	
Cell	inv			
View	symbol	>		
Names	Ĭ.	<b>-</b>		

Figure 3: Select symbol view of inv cell

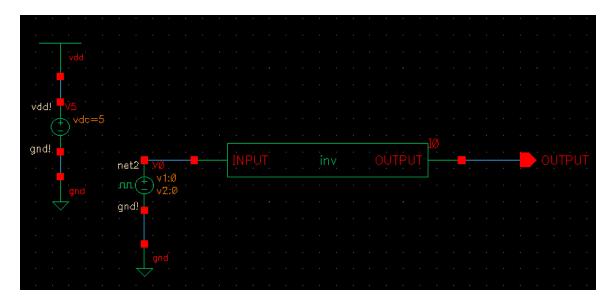


Figure 4: Schematic of inv\_sim

CMPE 315/CMPE640 UMBC

Now, we need to change the properties of vdc and vpulse. To change the property, click on the component and go to **Edit -> Properties -> Objects**. For vdc, set DC voltage to 5V as shown in Figure 5. For vpulse, set Voltage1 to 0V, Voltage2 to 5V, Delay time to 1ns, rise and fall times to 500ps, pulse width to 5ns and period to 10.1ns as shown in Figure 6.

♥ Edit	. Object	Properti	es					×
ок	Cancel	Apply	Defaults	Previous	Next		Hel	p
Apply To only current = instance =   Show system = user = CDF								
		Browse	Rese	t Instance	e Labels I	Display		
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	Cell Name		vdď	vdď			off 😑	
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	User F	roperty	Ma	ster Value		Local Value	Display	
	lvsigni	ore	TRUE		Ĭ.		off 😑	
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AC pha	ase		Ĭ				off =	
DC vol	tage		5	V			off 😑	
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Figure 5: Property of vdc used for the simulation

CDF Parameter	Value	Display
AC magnitude	Ĭ.	off 😑
AC phase	Ĭ.	off 😑
Voltage 1	0 v <u>ř</u>	off 😑
Voltage 2	5 V <u>ř</u>	off 🗆
Delay time	lnį́s	off 😑
Rise time	500 <u>p</u> i s	off 😑
Fall time	500př. s	off 😑
Pulse width	5n š	off 😑
Period	10.1n s	off 😑
DC voltage	<u>.</u>	off 😑

Figure 6: Property of vpulse used for the simulation

### **Hierarchy Editor**

Hierarchy Editor lets you change views of the cell for simulation. For example, if you have made the schematic and layout for the inverter, you can create only one simulation view and then switch between schematic or extracted layout in the simulation using Hierarchy Editor. You can also mix multiple view types of cells in simulation using Hierarchy Editor (This mean you can simulate schematic of adder connects to layout of multiplier and/or vhdl of control logic).

To create new Hierarchy Editor view, highlight inv\_sim cell in Library Manager, go to **File -> New -> Cell View** and select **Hierarchy-Editor** tool as shown in Figure 7.

✓ Create	New F	-ile				X
ОК	Canc	el	Defaults		He	lp
Library N	ame _		cr	npe315	_	_
Cell Name		in	nv_sim[			
View Name		C	onfigį́			
Tool	Tool Hierarchy-Editor =					
Library path file						
rs/e/k/ekarat2/home/cadence/cds.lib						
						$\geq$

*Figure 7: New Hierarchy Editor view* 

The New Configuration dialog will show up, click **Browse** and select schematic of inv\_sim as the top cell as shown in Figure 8. Then click **Use Template**, another dialog will appear as shown in Figure 9, select **spectreS** template and click OK. At View List, add "**extracted structural schematic**" separated by spaces exactly as shown in Figure 10. Click OK to close New Configuration dialog.

Now you will see Hierarchy Editor dialog as shown in Figure 11. From here, you can specify view you want to use in the simulation. For us, we will use schematic view of inverter in the simulation, so type in **schematic** in **View to Use** column of **inv** cell as shown in the figure. Click  $\blacksquare$  icon to save the configuration and then close the Hierarchy Editor.

Vew Configuration		3
Top Cell		
Library: cmpe315	Cell: inv_sim	View: schematic Browse
Global Bindings		
Library List:		
View List:		
Stop List:		
Description		
ОК	Cancel Use Tem	iplate Help

Figure 8: New Configuration

Template	
Name: 🤇	spectreS
From File:	ssetup/hierEditor/templates/spectreS

Figure 9: Use Template

Y	New Configu	Iration				//////////////////////////////////////
١r	Top Cell					
	Library: cmp	e315	Cell: inv_sim	Vie	w: schematic	Browse
Г	Global Bindin	gs		A	dd here!	
	Library List:	myLib				
	View List:	spectreS spice c	mos_sch cmos.sch	extracted str	uctural schematic	veriloga ahdl
	Stop List:	spectreS spice				

Figure 10: Add "extracted structural schematic" to View List

🗸 Cadence® hierarchy editor: New Configuration (Save Needed)							
File Edit View				Plug-Ins Help			
□ 🛋 🖬 )】 📴 ∽ ∼ 👙 🕕 龍 🏢 🛅							
Library: cmpe315 Cell: inv_sim View: schematic Open							
-Global Bindings-							
Library List: my	.ib						
View List: spe	ctreS spice cmos_sch cmo	os.sch extracted structu	ral schematic veriloga ahdl				
Stop List: spe	ctreS spice						
Cell Bindings							
Library	Cell	View Found	View to Use	Inherited View List			
NCSU_Analog_Pa	nmos4	spectreS		spectreS spice cmos_s			
NCSU_Analog_Pa	pmos4	spectreS		spectreS spice cmos_s			
analogLib	vpulse	spectreS		spectreS spice cmos_s			
cmpe315	inv	schematic	schematic	spectreS spice cmos_s			
cmpe315	inv_sim	schematic		spectreS spice cmos_s			

Figure 11: Hierarchy Editor

# **Open Analog Design Environment (ADE)**

Open the config view of inv\_sim cell (by double clicking), the dialog as shown in Figure 12 will show up, click OK. The schematic of inv\_sim should be opened, go to **Tools -> Analog Environment**. The ADE window should appear as shown in Figure 13.

✓ Open Configuration or Top CellView	×
OK Cancel	Help
Open for editing	
Configuration "cmpe315 inv_sim config"	🔷 yes 🔶 no
Top Cell View "cmpe315 inv_sim schematic"	🔶 yes 🔷 no

Figure 12: Open config view

▼ Virtuoso® Analog Desig	n Environment (1)	
Status: Ready	T=27 C Simulator: spectreS	25
Session Setup Analyses	Variables Outputs Simulation Results Tools	Help
Design	Analyses	Ļ
Library cmpe315	# Type Arguments Enable	⊐ AC F TRAN ⊐ DC
Cell inv_sim View config		IIII X Y Z
Design Variables	Outputs	l∎,
# Name Value	<pre># Name/Signal/Expr Value Plot Save March</pre>	ø
		\$
	Plotting mode: Replace 🖃	$\sim$
2		L

Figure13: Analog Design Environment

### **Simulation Setup**

Next, we need to set the type of analysis, stop time and accuracy level for the simulation. Go to **Analyses -> Choose**, the Choosing Analyses dialog will appear. Select **tran** for analysis type, enter **25n** (run simulation for 25ns) for stop time, click on **conservative** for accuracy mode and **Enabled** to enable this simulation setup as shown in Figure 14.

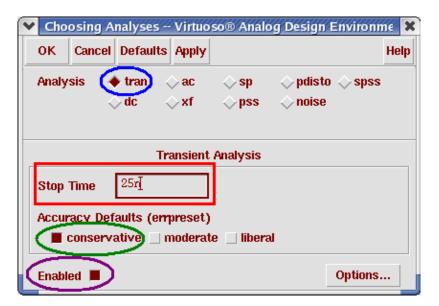


Figure 14: Choosing Analyses

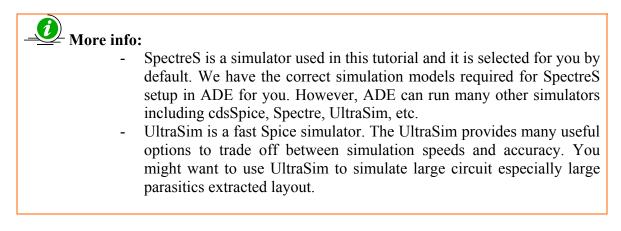
CMPE 315/CMPE640 UMBC

Next, we will select signals we want to observe after run simulation. Go to **Outputs -> To Be Plotted -> Select On Schematic**. Click on wires/nets on schematic that you want to observe. In our case, click wire connected to INPUT and OUTPUT of the inverter. The ADE window after having analyses and outputs setup is shown in Figure 15.

Session Setup Analyse	rts to be plotted T=27 C Simulator: spectreS s Variables Outputs Simulation Results Tools	Help
Design	Analyses	٠Ę
Library cmpe315	# Type Arguments Enable	⊐ AC F TRAN
<b>Cell</b> inv_sim	1 tran 0 25n cons yes	⊐ DC
<b>View</b> schematic		III III XYZ
Design Variables	Outputs	Œ
# Name Value	<pre># Name/Signal/Expr Value Plot Save March</pre>	
	1 net2 yes allv no 2 OUTPUT yes allv no	<i>≫</i> 1∰
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	Plotting mode: Replace -	+

Figure 15: ADE after analyses and outputs setup

Go to **Simulation -> Create Final**, the final netlist will appear as shown in Figure 16. If the netlist does not show up, see if there are any errors on CIW window or go to **Simulation -> Output Log**. (Note that this step may be skipped but we recommend you to run if you are setting the new simulation for the new cell.)



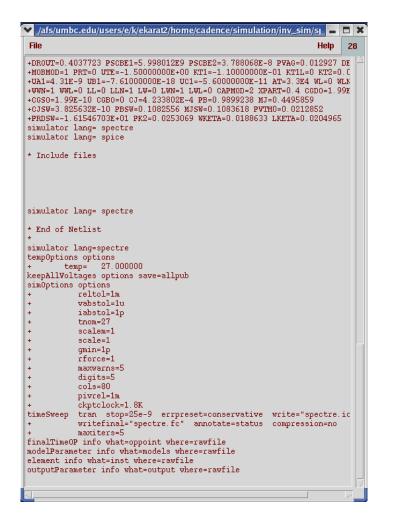


Figure 16: Created Final Netlist

## **Run Simulation**

Now run the simulation, go to Simulation -> Run. If the circuit is large, it might take times for the simulation to finish (depends on the size of the circuit, might take from few minutes to many hours). The information on running simulation is displayed on CIW window.

### Simulation Results on Waveform Window

After the simulation is finished, the waveform window will show up as shown in Figure 17. All signals selected will plotted on the same axes and difficult to look at some time. Go to **Axes -> To Strip** to have waveforms plotted on separate axes as shown in Figure 18.

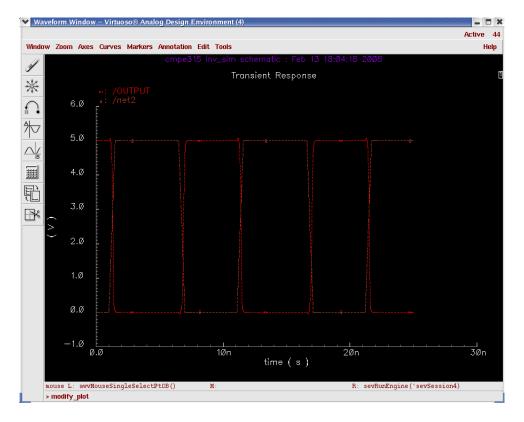


Figure 17: Waveform Window

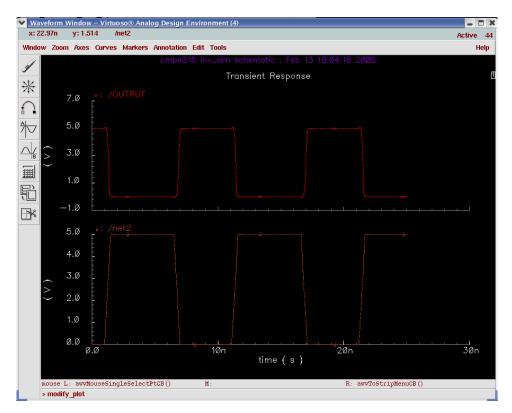


Figure 18: Waveform Window after Strip

### **Waveform Hardcopy**

To save waveforms displayed on Waveform Window, go to **Window** -> **Hardcopy**. Enter file name you want to be saved (postscript file).

#### Save State

You can save simulation setting so that next time you open ADE you do not need to setup Analyses and Output to be plotted (and any other settings) again. Go to **Session** -> Save State, enter state name as shown in Figure 19 and then click OK.

🗙 Sav	🗙 Saving State Virtuosoa Analog Design Environment (1)						
ок	Cancel Apply			Help			
Save	Save State Option						
Directo	Directory Options						
State	Save Directory	<pre>~/.artist_states</pre>		Browse			
	Save As	state1					
	Existing States						

Figure 19: Save State

# Load State

To load saved state, go to **Session -> Load State**, select the state you want to load from the list as shown in Figure 20.

🗙 Loading State Virtuosoa Analog Design Environment (1)					
ок	Cancel	Apply	Delete State		Help
Load State Option					
Directory Options					
State Load Directory		<pre>~/.artist_states]</pre>		Browse	
Library		cmpe315			
Cell		inv_sim =			
Simulator		spectre S =			
	State Na	me	state1		
		-			

Figure 20: Load State