

McKelvey School of Engineering

Spring Semester 2023

CSE463M-563M: Digital Integrated Circuit Design and Architecture

Homework #3

Reminder - Cadence wiki tutorial is located here:

<https://eda.engineering.wustl.edu/wiki/index.php/Cadence>

1) Inverter design problem (including layout) - 80 points

Design a CMOS inverter with the following specifications: device threshold of $V_{th} = 3V$, rise time $t_{rise} < 2ns$ and fall time $t_{fall} < 2ns$ if the load capacitance is 100fF. Also $V_{DD} = 5V$. Here is transistor data for AMI Semiconductor 0.5 micron process:

	NMOS	PMOS
K'	$120\mu A/V^2$	$-40\mu A/V^2$
V_{to}	0.8V	-0.8V
γ	0.6	0.6
λ	$0.06V^{-1}$	$0.06V^{-1}$
X_d (Under Diffusion)	6nm	6nm
NSUB	$1.3 \times 10^{16} cm^{-3}$	$4.8 \times 10^{16} cm^{-3}$
C_{ox}	$1.1 \times 10^{-3} F/m^2$	$1.1 \times 10^{-3} F/m^2$
$C_{gdo} = C_{gso}$	$6.6 \times 10^{-12} F/m$	$6.6 \times 10^{-12} F/m$
C_j	$2.8 \times 10^{-4} F/m^2$	$3 \times 10^{-4} F/m^2$
C_{jsw}	$1.7 \times 10^{-10} F/m$	$2.6 \times 10^{-10} F/m$

Present the following for your homework:

1.1) Show all hand calculations that you used to get the aspect ratios (W/L) of all transistors. In addition calculate propagation delay times τ_{PHL} and τ_{PLH} of the inverter.

1.2) Draw the schematic of the inverter in Cadence. Print the schematic.

1.3) Simulate the DC and transient behavior of the inverter schematic. Make any adjustments on the circuit in order to meet the above specifications. Plot the DC and transient characteristics. Show that your design meets requirements for V_{th} , t_{rise} and t_{fall} .

1.4) Draw the layout of this inverter. Try to make the layout as small as possible. Measure the size of the layout and use the ruler in layout to show the dimensions.

1.5) Run a DRC, extract the layout and LVS the design. Cut and Paste the messages generated in the CIW (the main Cadence window) when the DRC is executed. Print the LVS result – make sure it has successfully passed LVS.

1.6) Simulate the inverter extracted view. Again, the online tutorial explains how to simulate extracted view of the inverter. Plot the DC and transient characteristics of the inverter. If there are discrepancies (V_{th} , t_{rise} and t_{fall}) between the schematic and extracted simulations, explain why there are differences between the two simulations? Comment on both DC and transient simulations.

2) (80 points)

Create a ring oscillator by connecting 11 inverters in a loop. Use your inverter design from the Problem 1 as the starting point. Simulate the ring oscillator in Cadence Spice. Create the layout of the ring oscillator, run a DRC and LVS. Simulate the extracted view of the ring oscillator. Note: If you do not see any transient behavior at the output, you should set up output of the first inverter to be initially equal to 3V.

1.1)

$$V_{th} = \frac{V_{T0,n} + \sqrt{\frac{1}{k_R}} (V_{DD} - |V_{T0,p}|)}{1 + \sqrt{\frac{1}{k_R}}}$$

$$3 = \frac{0.8 + \sqrt{\frac{1}{k_R}} (5 - 0.8)}{1 + \sqrt{\frac{1}{k_R}}}$$

$$\boxed{k_R = 0.3}$$

$$k_R = \frac{k_n}{k_p} = \frac{k'_n (\frac{W}{L})_n}{k'_p (\frac{W}{L})_p} = \frac{120 (\frac{W}{L})_n}{40 (\frac{W}{L})_p} = \frac{3 (\frac{W}{L})_n}{(\frac{W}{L})_p}$$

$$0.3 (\frac{W}{L})_p = 3 (\frac{W}{L})_n$$

$$\boxed{\frac{W_p}{L_p} = 10 \frac{W_n}{L_n}}$$

+ I'm going to set PMOS L=600n and NMOS L=600n. And I would get the result like below.

$$\boxed{W_P = 6u, L_P = 600n}$$

$$\boxed{W_L = 600n, L_L = 600n}$$

$$\tau_{fall} = \frac{C_{load}}{\mu_n C_{ox} \frac{W_n}{L_n} (V_{DD} - V_{T0n})} \left[\frac{2(V_{T0n} - 0.1V_{DD})}{V_{DD} - V_{T0n}} + \ln \left(\frac{2(V_{DD} - V_{T0n})}{0.1V_{DD}} - 1 \right) \right]$$

$$2 \cdot 10^{-9} > \frac{100 \cdot 10^{-15}}{120 \cdot 10^{-6} \cdot \frac{W_n}{L_n} \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln \left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1 \right) \right]$$

$$\frac{W_n}{L_n} > \frac{100}{120 \cdot 2 \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln \left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1 \right) \right]$$

$$\boxed{\frac{W_n}{L_n} > 0.287}$$

$$\tau_{rise} = \frac{C_{load}}{\mu_p C_{ox} \frac{W_p}{L_p} (V_{DD} - |V_{T0p}|)} \left[\frac{2(|V_{T0p}| - 0.1V_{DD})}{V_{DD} - |V_{T0p}|} + \ln \left(\frac{2(V_{DD} - |V_{T0p}|)}{0.1V_{DD}} - 1 \right) \right]$$

$$2 \cdot 10^{-9} > \frac{100 \cdot 10^{-15}}{40 \cdot 10^{-6} \cdot \frac{W_p}{L_p} \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln \left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1 \right) \right]$$

$$\frac{W_p}{L_p} > \frac{100}{40 \cdot 2 \cdot (5 - 0.8)} \left[\frac{2(0.8 - 0.1 \cdot 5)}{5 - 0.8} + \ln \left(\frac{2(5 - 0.8)}{0.1 \cdot 5} - 1 \right) \right]$$

$$\boxed{\frac{W_p}{L_p} > 0.863}$$

$$\tau_{PHL} = \frac{C_{load}}{\mu_n C_{ox} (V_{DD} - V_{T0n})} \left(\frac{L_n}{W_n} \right) \left[\frac{2V_{T0n}}{V_{DD} - V_{T0n}} + \ln \left(\frac{4(V_{DD} - V_{T0n})}{V_{DD}} - 1 \right) \right]$$

$$\tau_{PHL} = \frac{100 \cdot 10^{-15}}{120 \cdot 10^{-6} (5 - 0.8)} \cdot 1 \cdot \left[\frac{2 \cdot 0.8}{5 - 0.8} + \ln \left(\frac{4(5 - 0.8)}{5} - 1 \right) \right]$$

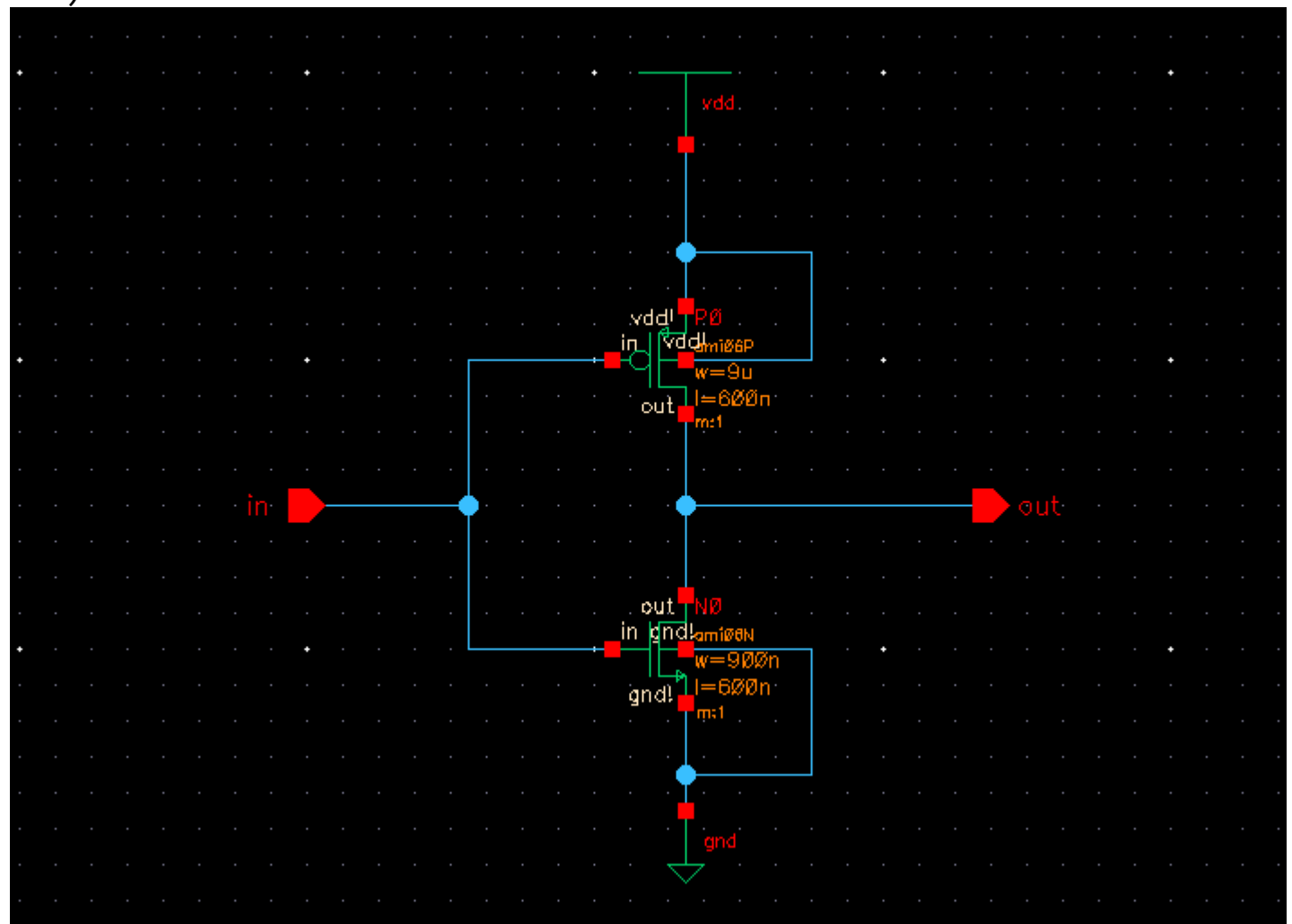
$$\boxed{\tau_{PHL} = 0.245 \text{ ns}}$$

$$\tau_{PLH} = \frac{C_{load}}{\mu_p C_{ox} (V_{DD} - |V_{T0p}|)} \left(\frac{L_p}{W_p} \right) \left[\frac{2|V_{T0p}|}{V_{DD} - |V_{T0p}|} + \ln \left(\frac{4(V_{DD} - |V_{T0p}|)}{V_{DD}} - 1 \right) \right]$$

$$\tau_{PLH} = \frac{100 \cdot 10^{-15}}{120 \cdot 10^{-6} (5 - 0.8)} \cdot 0.1 \cdot \left[\frac{2 \cdot 0.8}{5 - 0.8} + \ln \left(\frac{4(5 - 0.8)}{5} - 1 \right) \right]$$

$$\boxed{\tau_{PLH} = 0.0245 \text{ ns}}$$

1.2)

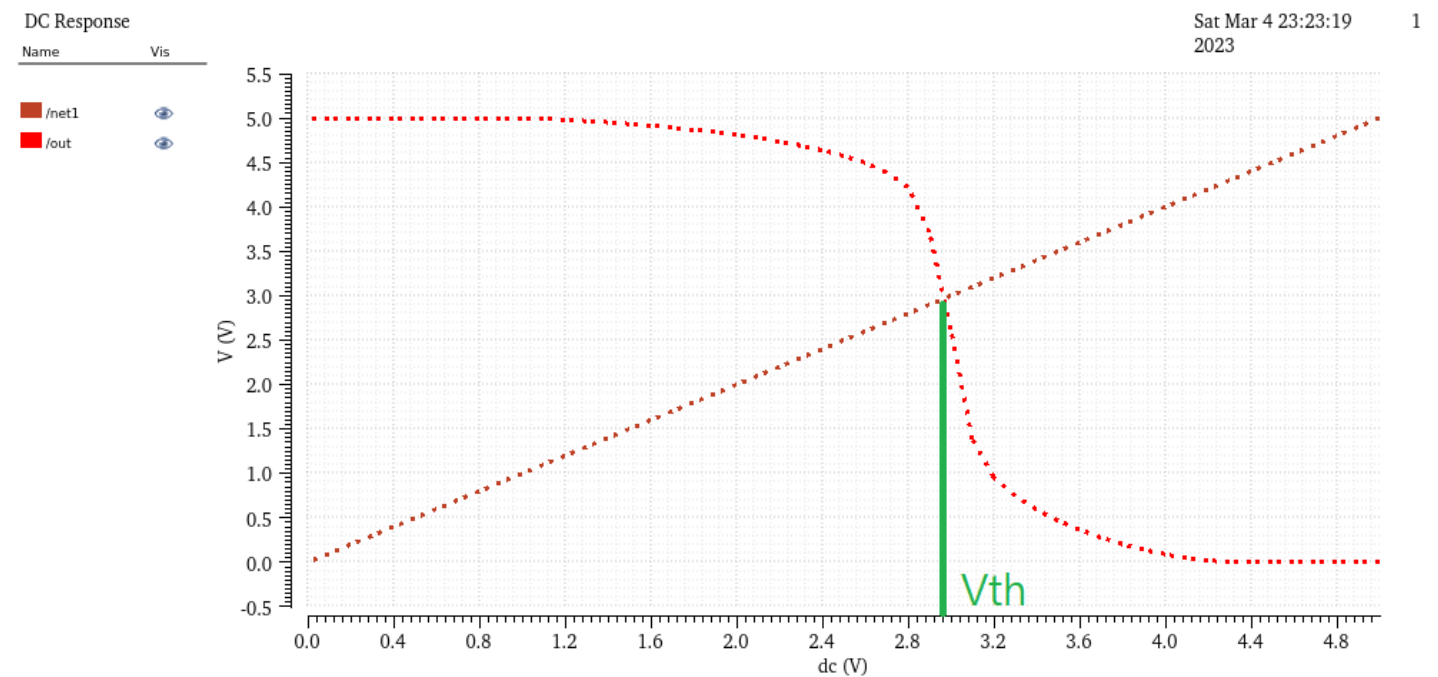


1.3)

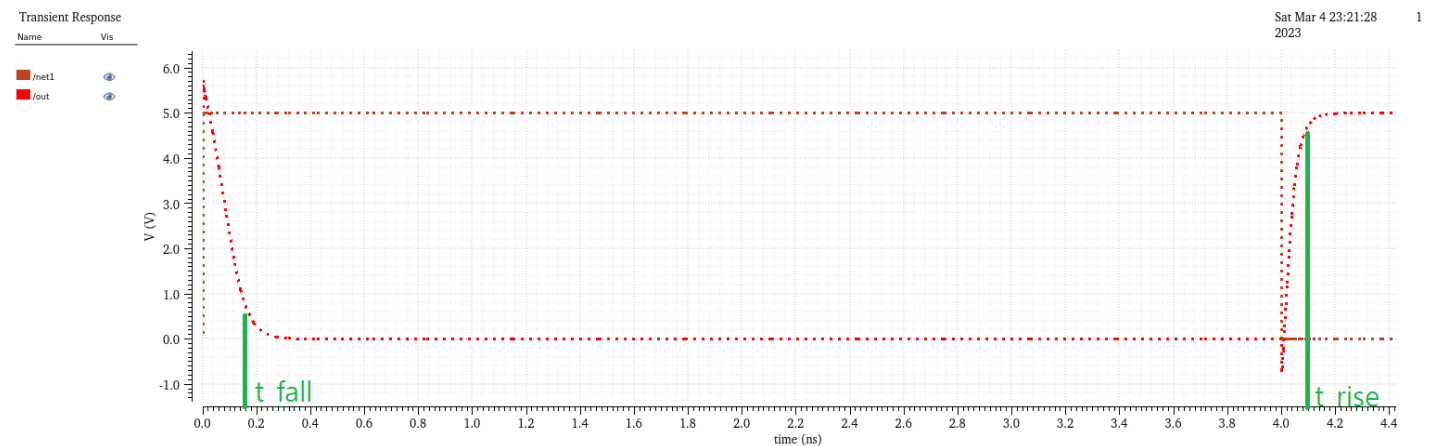
+ I've set the W/L from the result Q1 but I could not get the right V_{th} . So I adjust the value a little bit and I found the result like below.

$$W_P = 3.6u, L_P = 600n$$
$$W_L = 1.2u, L_L = 600n$$

+ You can see the V_{th} value is 3V



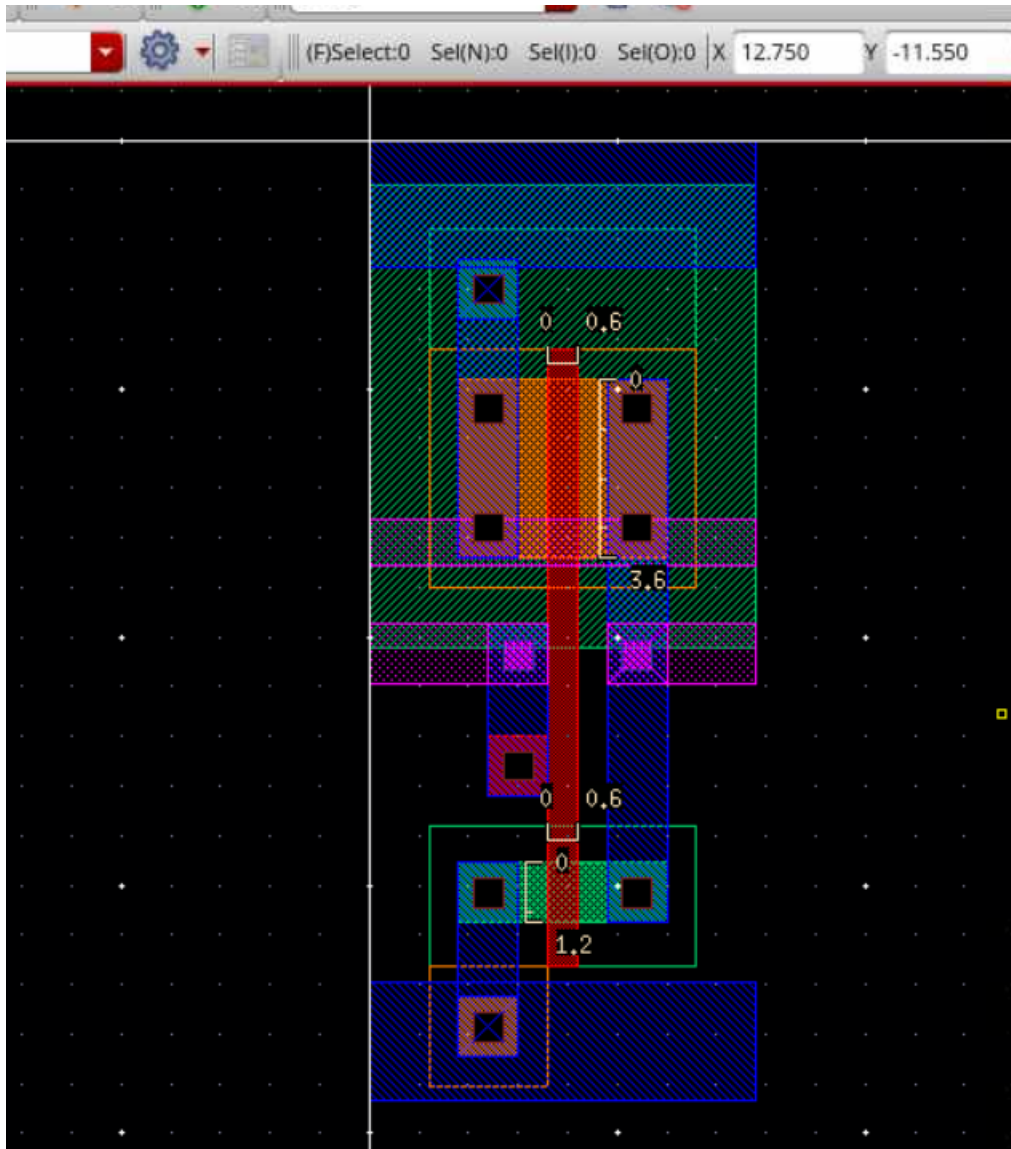
+ You can see the t_{fall} and t_{rise} is less than 2n second.



1.4)

+ We can see the length of W, L in a image below.

$$\begin{array}{l} W_P = 3.6u, L_P = 600n \\ W_L = 1.2u, L_L = 600n \end{array}$$



1.5)

+ DRC result

```
Validating hierarchy instantiation for:
library: cse463
cell:    inv_homework3
view:    layout
Rules come from library NCSU_TechLib_ami06.
Rules path is divaDRC.rul.
Inclusion limit is set to 1000.
Parsing      drcExtractRules      of      "/project/linuxlab/cadence/CDK/ncsu-cdk-
1.6.0.beta/lib/NCSU_TechLib_ami06/divaDRC.rul"...
Optimizing rules...
removing unused task: nwellResEdge = geomGetEdge(nwellRes coincident nwell)
removing unused task: polyResEdge = geomGetEdge(polyRes coincident poly)
removing unused task: elecEdge = geomGetEdge(elec)
removing unused task: padEdge = geomGetEdge(pad)
removing unused task: ccEdge = geomGetEdge(cc)
removing unused task: gselectEdge = geomGetEdge(gselect)
removing unused task: gwellEdge = geomGetEdge(gwell)
removing unused task: nwellRes = geomButting(geomAnd(res_id nwell) nBulk (keep == 2))
removing unused task: polyRes = geomButting(geomAnd(res_id poly) fieldPoly (keep == 2))
removing unused task: NwPdiode = geomAnd(dio_id geomOutside(nwell pNotOhmic))
removing unused task: PNdiode = geomAnd(dio_id geomOutside(pNotOhmic poly))
removing unused task: NPdiode = geomAnd(dio_id geomOutside(nNotOhmic poly))
removing unused task: m3m2Cap = geomAnd(geomAnd(metal2 metal3) cap_id)
removing unused task: m2m1Cap = geomAnd(geomAnd(metal1 metal2) cap_id)
removing unused task: m1sCap = geomAnd(geomAndNot(metal1 poly) cap_id)
removing unused task: m1pCap = geomAnd(geomAnd(poly metal1) cap_id)
removing unused task: pChannelCap = geomButting(pChannel pDiff (keep == 1))
removing unused task: nChannelCap = geomButting(nChannel nDiff (keep == 1))
removing unused task: pChannelTran = geomButting(pChannel pDiff (keep == 2))
removing unused task: nChannelTran = geomButting(nChannel nDiff (keep == 2))
removing unused task: Space = geomNot(geomOr(active poly elec))
removing unused task: pElecChannelCap = geomButting(pElecChannel pDiff (keep == 1))
removing unused task: nElecChannelCap = geomButting(nElecChannel nDiff (keep == 1))
removing unused task: pElecChannelTran = geomButting(pElecChannel pDiff (keep == 2))
removing unused task: nElecChannelTran = geomButting(nElecChannel nDiff (keep == 2))
removing unused task: pElecChannel = geomOutside(geomAnd(pNotOhmic elec) poly)
removing unused task: nElecChannel = geomOutside(geomAnd(nNotOhmic elec) poly)
removing unused task: pChannel = geomOutside(geomAnd(pNotOhmic poly) elec)
removing unused task: nChannel = geomOutside(geomAnd(nNotOhmic poly) elec)
removing unused task: dio_id = geomOr("dio_id")
removing unused task: cap_id = geomOr("cap_id")
removing unused task: nolpe = geomOr("nolpe")
removing unused task: bkgnd = geomBkgnd()
Running layout DRC analysis
Flat mode
Full checking.
executing: nodrc = geomOr("nodrc")
executing: gwell = geomOr(geomAndNot(("gwell" "drawing") nodrc))
executing: nwell = geomOr(geomAndNot(("nwell" "drawing") nodrc))
executing: pwell = geomOr(geomAndNot(("pwell" "drawing") nodrc))
executing: nactive = geomOr(geomAndNot(("nactive" "drawing") nodrc))
executing: pactive = geomOr(geomAndNot(("pactive" "drawing") nodrc))
executing: active = geomOr(geomAndNot(("active" "drawing") nodrc) nactive pactive)
executing: gselect = geomOr(geomAndNot(("gselect" "drawing") nodrc))
executing: nselect = geomOr(geomAndNot(("nselect" "drawing") nodrc))
executing: pselect = geomOr(geomAndNot(("pselect" "drawing") nodrc))
executing: poly = geomOr(geomAndNot(("poly" "drawing") nodrc))
executing: metal1 = geomOr(geomAndNot(("metal1" "drawing") nodrc))
executing: cc = geomOr(geomAndNot(("cc" "drawing") nodrc))
executing: metal2 = geomOr(geomAndNot(("metal2" "drawing") nodrc))
executing: via = geomOr(geomAndNot(("via" "drawing") nodrc))
executing: glass = geomOr(geomAndNot(("glass" "drawing") nodrc))
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executing: pad = geomOr(geomAndNot(("pad" "drawing") nodrc))
executing: res_id = geomOr("res_id")
executing: metal3 = geomOr(geomAndNot(("metal3" "drawing") nodrc))
executing: via2 = geomOr(geomAndNot(("via2" "drawing") nodrc))
executing: highres = geomOr(geomAndNot(("highres" "drawing") nodrc))
executing: elec = geomOr(geomAndNot(("elec" "drawing") nodrc))
executing: ce = geomOr(geomOr(geomAndNot(("ce" "drawing") nodrc)) geomAnd(cc elec))
executing: cp = geomOr(geomOr(geomAndNot(("cp" "drawing") nodrc)) geomAnd(cc geomAndNot(poly ce)))
executing: ca = geomOr(geomOr(geomAndNot(("ca" "drawing") nodrc)) geomAnd(cc geomAndNot(active ...
executing: nActive = geomAnd(active nselect)
executing: pActive = geomAnd(active pselect)
executing: nBulk = geomOr(nwell)
executing: pBulk = geomOr(geomNot(nwell) geomAndNot(pwell nwell))
executing: nOhmic = geomAnd(nActive nwell)
executing: nNotOhmic = geomAndNot(nActive nwell)
executing: pOhmic = geomAndNot(pActive nwell)
executing: pNotOhmic = geomAnd(pActive nwell)
executing: nDiff = geomAndNot(nNotOhmic geomOr(poly elec))
executing: pDiff = geomAndNot(pNotOhmic geomOr(poly elec))
executing: nDiffContact = geomAnd(ca nDiff)
executing: pDiffContact = geomAnd(ca pDiff)
executing: nOhmicContact = geomAnd(ca nOhmic)
executing: pOhmicContact = geomAnd(ca pOhmic)
executing: Gate = geomAnd(geomOr(nNotOhmic pNotOhmic) poly)
executing: fieldPoly = geomAvoiding(poly Gate)
executing: elecGate = geomAnd(geomOr(nNotOhmic pNotOhmic) elec)
executing: fieldElec = geomAvoiding(elec elecGate)
executing: CapacitorElec = geomInside(elec poly)
executing: TransistorElec = geomOverlap(elec geomNot(poly))
executing: fieldPoly = geomAndNot(fieldPoly res_id)
executing: poly = geomAndNot(poly res_id)
executing: fieldElec = geomAndNot(fieldElec geomOr(res_id highres))
executing: elecRes = geomButting(geomAnd(res_id elec) fieldElec (keep == 2))
executing: elecHighres = geomButting(geomAnd(highres elec) fieldElec (keep == 2))
executing: elec = geomAndNot(elec geomOr(res_id highres))
executing: nBulk = geomAndNot(nBulk res_id)
executing: nwell = geomAndNot(nwell res_id)
executing: geomConnect((via nOhmicContact nOhmic nwell nBulk metal1) (via pOhmicContact pOhmic ...
executing: dubiousData(("gwell" "drawing") "Improperly formed shape - gwell")
executing: dubiousData(("nwell" "drawing") "Improperly formed shape - nwell")
executing: dubiousData(("pwell" "drawing") "Improperly formed shape - pwell")
executing: dubiousData(("active" "drawing") "Improperly formed shape - active, nactive or pactive...
executing: dubiousData(("gselect" "drawing") "Improperly formed shape - gselect")
executing: dubiousData(("nselect" "drawing") "Improperly formed shape - nselect")
executing: dubiousData(("pselect" "drawing") "Improperly formed shape - pselect")
executing: dubiousData(("poly" "drawing") "Improperly formed shape - poly")
executing: dubiousData(("metal1" "drawing") "Improperly formed shape - metal1")
executing: dubiousData(("ca" "drawing") "Improperly formed shape - ca")
executing: dubiousData(("cp" "drawing") "Improperly formed shape - cp")
executing: dubiousData(("metal2" "drawing") "Improperly formed shape - metal2")
executing: dubiousData(("via" "drawing") "Improperly formed shape - via")
executing: dubiousData(("glass" "drawing") "Improperly formed shape - glass")
executing: saveDerived(geomGetNon45(gwell) "Non-Manhattan shape - gwell")
executing: saveDerived(geomGetNon45(nwell) "Non-Manhattan shape - nwell")
executing: saveDerived(geomGetNon45(pwell) "Non-Manhattan shape - pwell")
executing: saveDerived(geomGetNon45(active) "Non-Manhattan shape - active, nactive or pactive")
executing: saveDerived(geomGetNon45(gselect) "Non-Manhattan shape - gselect")
executing: saveDerived(geomGetNon45(nselect) "Non-Manhattan shape - nselect")
executing: saveDerived(geomGetNon45(pselect) "Non-Manhattan shape - pselect")
executing: saveDerived(geomGetNon45(poly) "Non-Manhattan shape - poly")
executing: saveDerived(geomGetNon45(metal1) "Non-Manhattan shape - metal1")
executing: saveDerived(geomGetNon45(ca) "Non-Manhattan shape - ca")
executing: saveDerived(geomGetNon45(cp) "Non-Manhattan shape - cp")
executing: saveDerived(geomGetNon45(metal2) "Non-Manhattan shape - metal2")
executing: saveDerived(geomGetNon45(via) "Non-Manhattan shape - via")

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executing: saveDerived(geomGetNon45(glass) "Non-Manhattan shape - glass")
executing: offGrid(gwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(pwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(active gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(gselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(pselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(poly gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal1 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ca gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(cp gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal2 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(glass gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("metal3" "drawing") "Improperly formed shape - metal3")
executing: dubiousData(("via2" "drawing") "Improperly formed shape - via2")
executing: saveDerived(geomGetNon45(metal3) "Non-Manhattan shape - metal3")
executing: saveDerived(geomGetNon45(via2) "Non-Manhattan shape - via2")
executing: offGrid(metal3 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via2 gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("elec" "drawing") "Improperly formed shape - elec")
executing: dubiousData(("ce" "drawing") "Improperly formed shape - ce")
executing: saveDerived(geomGetNon45(elec) "Non-Manhattan shape - elec")
executing: saveDerived(geomGetNon45(ce) "Non-Manhattan shape - ce")
executing: offGrid(elec gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ce gridRes "(SCMOS Inst) Edge not on grid")
executing: nwellEdge = geomGetEdge(nwell)
executing: pwellEdge = geomGetEdge(pwell)
executing: activeEdge = geomGetEdge(active)
executing: nselectEdge = geomGetEdge(nselect)
executing: pselectEdge = geomGetEdge(pselect)
executing: polyEdge = geomGetEdge(poly)
executing: metal1Edge = geomGetEdge(metal1)
executing: caEdge = geomGetEdge(ca)
executing: cpEdge = geomGetEdge(cp)
executing: metal2Edge = geomGetEdge(metal2)
executing: viaEdge = geomGetEdge(via)
executing: glassEdge = geomGetEdge(glass)
executing: highresEdge = geomGetEdge(highres)
executing: ceEdge = geomGetEdge(ce)
executing: metal3Edge = geomGetEdge(metal3)
executing: via2Edge = geomGetEdge(via2)
executing: nBulkEdge = geomGetEdge(nBulk)
executing: pBulkEdge = geomGetEdge(pBulk)
executing: nOhmicEdge = geomGetEdge(nOhmic)
executing: pOhmicEdge = geomGetEdge(pOhmic)
executing: nNotOhmicEdge = geomGetEdge(nNotOhmic)
executing: pNotOhmicEdge = geomGetEdge(pNotOhmic)
executing: GateEdge = geomGetEdge(Gate)
executing: fieldPolyEdge = geomGetEdge(fieldPoly)
executing: CapacitorElecEdge = geomGetEdge(CapacitorElec)
executing: TransistorElecEdge = geomGetEdge(TransistorElec)
executing: elecHighresEdge = geomGetEdge(elecRes coincident elec)
executing: saveDerived(geomAndNot(active geomOr(nselect pselect)) "(DBM Rule 1.1) Active must b...")
executing: saveDerived(geomAnd(poly nOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(poly pOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec nOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec pOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(pactive nselect) "(DBM Rule 3.1) Pactive and Nselect may not ove...")
executing: saveDerived(geomAnd(nactive pselect) "(DBM Rule 3.2) Nactive and Pselect may not ove...")
executing: saveDerived(geomAnd(active elec) "(DBM Rule 4.0, AMI 0.6um) Elec and active may not ...")
executing: drc(nwellEdge (width < (lambda * 12.0)) errMesg)
executing: drc(nwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(pwellEdge (width < (lambda * 12.0)) errMesg)

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drc(pwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(nwell (sep < (lambda * 18.0)) diffNet errMesg)
drc(nwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: drc(pwell (sep < (lambda * 18.0)) diffNet errMesg)
drc(pwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: saveDerived(geomAnd(nwell pwell) "(SCMOS Rule 1 note) n-wells and p-wells may not ov...
executing: drc(activeEdge (width < (lambda * 3.0)) errMesg)
drc(activeEdge (sep < (lambda * 3.0)) errMesg)
drc(activeEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge nBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pNotOhmicEdge pBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pBulkEdge nNotOhmicEdge (enc < (lambda * 6.0)) errMesg)
executing: drc(nBulkEdge pNotOhmicEdge (enc < (lambda * 6.0)) errMesg)
executing: drc(nBulkEdge nOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nOhmicEdge pBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pOhmicEdge nBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pBulkEdge pOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge pOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(pNotOhmicEdge nOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(polyEdge (width < (lambda * 2.0)) errMesg)
drc(polyEdge (sep < (lambda * 3.0)) errMesg)
drc(polyEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge activeEdge (enc < (lambda * 2.0)) errMesg)
drc(activeEdge polyEdge (enc < (lambda * 3.0)) errMesg)
drc(polyEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(nselectEdge geomGetEdge(polyEdge inside pNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(nselectEdge geomGetEdge(polyEdge inside nNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside nNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside pNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(geomOr(nselectEdge pselectEdge) activeEdge (sep < (lambda * 2.0)) errMesg)
drc(geomOr(nselectEdge pselectEdge) activeEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(nselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
drc(nselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(pselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
drc(pselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomButting(geomAnd(ca nselect) geomAnd(ca pselect)) errMesg)
executing: drc(nselectEdge (width < (lambda * 2.0)) errMesg)
drc(nselectEdge (sep < (lambda * 2.0)) errMesg)
drc(nselectEdge (notch < (lambda * 2.0)) errMesg)
executing: drc(pselectEdge (width < (lambda * 2.0)) errMesg)
drc(pselectEdge (sep < (lambda * 2.0)) errMesg)
drc(pselectEdge (notch < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(nselect pselect) errMesg)
executing: drc(cpEdge (width < (lambda * 2.0)) errMesg)
drc(cpEdge (sep < (lambda * 3.0)) errMesg)
drc(cpEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(cp (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(polyEdge cpEdge (enc < (lambda * 1.0)) errMesg)
drc(cpEdge polyEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(cp poly) errMesg)
executing: saveDerived(geomAndNot(cc geomOr(poly elec active)) errMesg)
executing: drc(cpEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(cpEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(cp active) errMesg)
executing: saveDerived(geomGetLength(drc(cpEdge activeEdge (sep < (lambda * 3.0))) (length > (1...
executing: drc(caEdge (width < (lambda * 2.0)) errMesg)
drc(caEdge (sep < (lambda * 3.0)) errMesg)
drc(caEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ca (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(activeEdge caEdge (enc < (lambda * 1.0)) errMesg)
drc(caEdge activeEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(ca active) errMesg)
executing: drc(caEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(ca Gate) errMesg)
executing: drc(caEdge fieldPolyEdge (sep < (lambda * 2.0)) errMesg)

```

```

executing: saveDerived(geomAnd(ca fieldPoly) errMesg)
executing: saveDerived(geomGetLength(drc(caEdge fieldPolyEdge (sep < (lambda * 3.0))) (length >...
executing: drc(caEdge cpEdge (sep < (lambda * 4.0)) errMesg)
executing: saveDerived(geomAnd(ca cp) errMesg)
executing: drc(metal1Edge (width < (lambda * 3.0)) errMesg)
           drc(metal1Edge (sep < (lambda * 3.0)) errMesg)
           drc(metal1Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal1Edge cpEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(metal1Edge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(cp metal1) errMesg)
executing: saveDerived(geomAndNot(ca metal1) errMesg)
executing: drc(viaEdge (width < (lambda * 2.0)) errMesg)
           drc(viaEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(via (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1))))...
executing: drc(metal1Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal1) errMesg)
executing: drc(metal2Edge (width < (lambda * 3.0)) errMesg)
           drc(metal2Edge (sep < (lambda * 3.0)) errMesg)
           drc(metal2Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal2Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal2) errMesg)
executing: BondingGlass = geomInside(glass pad)
           ProbeGlass = geomOutside(glass pad)
executing: saveDerived(geomStraddle(glass pad))
executing: BondingPad = geomAndNot(geomSize(BondingGlass 6.0) geomHoles(BondingGlass))
executing: ProbePad = geomAndNot(geomSize(ProbeGlass 6.0) geomHoles(ProbeGlass))
executing: Pad = geomOr(BondingPad ProbePad)
executing: BondingPadEdge = geomGetEdge(BondingPad not_over "nodrc")
executing: ProbePadEdge = geomGetEdge(ProbePad not_over "nodrc")
executing: PadEdge = geomGetEdge(Pad not_over "nodrc")
executing: Metal3EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal3" "glass" 36.0)) not_ov...
executing: Metal2EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal2" "glass" 36.0)) not_ov...
executing: Metal1EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal1" "glass" 21.0)) not_ov...
executing: PolyEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("poly" "glass" 21.0)) not_over "...
executing: ActiveEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("active" "glass" 21.0)) not_ov...
executing: ElecEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("elec" "glass" 21.0)) not_over "...
executing: drc(BondingPadEdge (width < 60.0) "(SCMOS Rule 10.1) bonding pad width: 60 um")
executing: drc(ProbePadEdge (width < 20.0) "(SCMOS Rule 10.2) probe pad width: 20 um")
executing: drc(Metal3EdgeNearPad glassEdge (enc < 6.0) "(SCMOS Rule 10.3) pad enclosure of glas...
executing: saveDerived(geomAndNot(glass metal3) "(SCMOS Rule 10.3) pad enclosure of glass: 6 um")
executing: drc(PadEdge Metal3EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal2EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal1EdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated metal...
executing: drc(PadEdge PolyEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated poly sp...
executing: drc(PadEdge ActiveEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated activ...
executing: drc(PadEdge ElecEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated elec sp...
executing: drc(CapacitorElecEdge (width < (lambda * 7.0)) errMesg)
           drc(CapacitorElecEdge (sep < (lambda * 3.0)) errMesg)
           drc(CapacitorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge CapacitorElecEdge (enc < (lambda * 5.0)) errMesg)
executing: drc(CapacitorElecEdge nBulkEdge (sep < (lambda * 2.0)) errMesg)
           drc(nBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(CapacitorElecEdge pBulkEdge (sep < (lambda * 2.0)) errMesg)
           drc(pBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec nBulk) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec pBulk) errMesg)
executing: drc(CapacitorElecEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(CapacitorElec active) errMesg)
executing: drc(CapacitorElecEdge cpEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal3") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal3 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal2") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal2 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal1") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal1 elec diffNet) errMesg)

```

```

executing: drc(TransistorElecEdge (width < (lambda * 2.0)) errMesg)
           drc(TransistorElecEdge (sep < (lambda * 3.0)) errMesg)
           drc(TransistorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge activeEdge (enc < (lambda * 2.0)) errMesg)
           drc(TransistorElecEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(TransistorElecEdge polyEdge (sep < (lambda * 2.0)) errMesg)
           drc(TransistorElecEdge polyEdge (ovlp < (lambda * 2.0)) errMesg)
executing: drc(TransistorElecEdge cpEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec cp) errMesg)
executing: drc(TransistorElecEdge caEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec ca) errMesg)
executing: drc(ceEdge (width < (lambda * 2.0)) errMesg)
           drc(ceEdge (sep < (lambda * 3.0)) errMesg)
           drc(ceEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ce (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(CapacitorElecEdge ceEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge ceEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(ce elec) "(SCMOS Rules 13.3,13.4) electrode enclosure of cont...)
executing: drc(ceEdge polyEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomOutside(geomAnd(ce poly) CapacitorElec) errMesg)
executing: drc(ceEdge activeEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(ce active) errMesg)
executing: drc(via2Edge (width < (lambda * 2.0)) errMesg)
           drc(via2Edge (sep < (lambda * 3.0)) errMesg)
executing: drc(via2 (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1))))...
executing: drc(metal2Edge via2Edge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal2) errMesg)
executing: drc(metal3Edge (width < (lambda * 5.0)) errMesg)
           drc(metal3Edge (sep < (lambda * 3.0)) errMesg)
           drc(metal3Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal3Edge via2Edge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal3) errMesg)
executing: drc(highresEdge (width < (lambda * 4.0)) errMesg)
           drc(highresEdge (sep < (lambda * 4.0)) errMesg)
           drc(highresEdge (notch < (lambda * 4.0)) errMesg)
executing: drc(highresEdge caEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge cpEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(highres ca) errMesg)
executing: saveDerived(geomAnd(highres cp) errMesg)
executing: drc(highresEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge geomGetEdge(geomAndNot(elec geomButting(elec elecHighres))) (sep < (...
executing: saveDerived(geomButting(elecHighres geomAndNot(elec elecHighres) (ignore == 2)) errM...
executing: saveDerived(geomAnd(elecHighres nwell) "(SCMOS Rule 27.6) resistor must be outside w...
executing: saveDerived(geomAnd(elecHighres active) "(SCMOS Rule 27.6) resistor must be outside ...
executing: drc(elecHighresEdge (width < (lambda * 5.0)) errMesg)
           drc(elecHighresEdge (sep < (lambda * 7.0)) errMesg)
           drc(elecHighresEdge (notch < (lambda * 7.0)) errMesg)
executing: drc(highresEdge elecHighresEdge (enc < (lambda * 2.0)) errMesg)
DRC started.....Sun Mar  5 14:23:48 2023
  completed ....Sun Mar  5 14:23:48 2023
  CPU TIME = 00:00:00  TOTAL TIME = 00:00:00
***** Summary of rule violations for cell "inv_homework3 layout" *****
Total errors found: 0

```

```
@(#)$CDS: LVS version 6.1.8-64b 08/09/2022 19:10 (sjfhw317) $
```

```

Command      line:          /project/engineering/cadence21/IC618/tools.lnx86/dfII/bin/64bit/LVS      -dir
/home/warehouse/b.gwak/cadence/LVS      -l      -s      -t      /home/warehouse/b.gwak/cadence/LVS/layout
/home/warehouse/b.gwak/cadence/LVS/schematic
Like matching is enabled.
Net swapping is enabled.
Using terminal names as correspondence points.
Compiling Diva LVS rules...

```

```
Net-list summary for /home/warehouse/b.gwak/cadence/LVS/layout/netlist
```

```
count
4      nets
4      terminals
1      pmos
1      nmos
```

Net-list summary for /home/warehouse/b.gwak/cadence/LVS/schematic/netlist

```
count
4      nets
4      terminals
1      pmos
1      nmos
```

Terminal correspondence points

```
N1      N1      gnd!
N4      N5      in
N3      N3      out
N2      N0      vdd!
```

Devices in the netlist but not in the rules:

pcapacitor

Devices in the rules but not in the netlist:

cap nfet pfet nmos4 pmos4

The net-lists match.

	layout	schematic
	instances	
un-matched	0	0
rewired	0	0
size errors	0	0
pruned	0	0
active	2	2
total	2	2

	nets	
un-matched	0	0
merged	0	0
pruned	0	0
active	4	4
total	4	4

	terminals	
un-matched	0	0
matched but		
different type	0	0
total	4	4

Probe files from /home/warehouse/b.gwak/cadence/LVS/schematic

```
devbad.out:
netbad.out:
mergenet.out:
termbad.out:
prunenet.out:
prunedev.out:
audit.out:
```

Probe files from /home/warehouse/b.gwak/cadence/LVS/layout

```
devbad.out:
netbad.out:
mergenet.out:
termbad.out:
prunenet.out:
prunedev.out:
audit.out:
```

1.6)

+ This box shows that I tested on extracted version.

```
// Generated for: spectre
// Generated on: Mar  5 14:41:25 2023
// Design library name: cse463
// Design cell name: inv_test
// Design view name: schematic
simulator lang=spectre
global 0 vdd!
include "/project/linuxlab/cadence/CDK/ncsu/models/spectre/nom/ami06N.m"
include "/project/linuxlab/cadence/CDK/ncsu/models/spectre/nom/ami06P.m"

// Library name: cse463
// Cell name: inv_homework3
// View name: extracted
// View type: maskLayout
subckt inv_homework3 in out
  \+1 (out in vdd! vdd!) ami06P w=3.6e-06 l=6e-07 as=6.48e-12 \
    ad=6.48e-12 ps=7.2e-06 pd=7.2e-06 m=1 region=sat
  \+15 (in 0) capacitor c=4.2687e-16 m=1
  \+14 (in vdd!) capacitor c=1.3392e-16 m=1
  \+13 (vdd! 0) capacitor c=1.59252e-15 m=1
  \+12 (out 0) capacitor c=9.5022e-16 m=1
  \+11 (out vdd!) capacitor c=4.4736e-16 m=1
  \+10 (in 0) capacitor c=4.4736e-16 m=1
  \+9 (in vdd!) capacitor c=2.7354e-16 m=1
  \+8 (vdd! 5) capacitor c=9.0675e-16 m=1
  \+7 (out 5) capacitor c=2.8407e-16 m=1
  \+6 (out 0) capacitor c=2.4585e-16 m=1
  \+5 (out vdd!) capacitor c=2.1951e-16 m=1
  \+4 (in 5) capacitor c=1.5288e-16 m=1
  \+3 (in 0) capacitor c=3.153e-16 m=1
  \+2 (in vdd!) capacitor c=2.8518e-16 m=1
  \+0 (out in 0 0) ami06N w=1.2e-06 l=6e-07 as=2.16e-12 ad=2.16e-12 \
    ps=4.8e-06 pd=4.8e-06 m=1 region=sat
ends inv_homework3
// End of subcircuit definition.

// Library name: cse463
// Cell name: inv_test
// View name: schematic
I6 (net1 out) inv_homework3
V1 (vdd! 0) vsourc type=dc dc=5
C0 (out 0) capacitor c=1f m=1
V0 (net1 0) vsourc type=pulse val0=0 val1=5 period=8n delay=0 rise=1p \
  fall=1p width=4n
simulatorOptions options psfversion="1.4.0" reitol=1e-3 vabstol=1e-6 \
  iabstol=1e-12 temp=27 tnom=27 scalem=1.0 scale=1.0 gmin=1e-12 rforce=1 \
  maxnotes=5 maxwarns=5 digits=5 cols=80 pivrel=1e-3 \
  sensfile="../psf/sens.output" checklimitdest=psf
dc dc dev=V0 param=dc start=0 stop=5 write="spectre.dc" oppoint=rawfile \
  maxiters=150 maxsteps=10000 annotate=status
tran tran stop=16n write="spectre.ic" writefinal="spectre.fc" \
  annotate=status maxiters=5
finalTimeOP info what=oppoint where=rawfile
modelParameter info what=models where=rawfile
element info what=inst where=rawfile
outputParameter info what=output where=rawfile
designParamVals info what=parameters where=rawfile
primitives info what=primitives where=rawfile
subckts info what=subckts where=rawfile
saveOptions options save=allpub
```

+ V_{th} didn't show any meaningful changes on extracted version. But t_{fall} , t_{rise} took longer on extracted version. I think it is because of parasitic capacitances. Because the magnetic field caused by parasitic capacitances effected on the inverter.

* Tested on not extracted version

V_{th} : 2.96 V

t_{fall} : 176ps to reach the 500mV

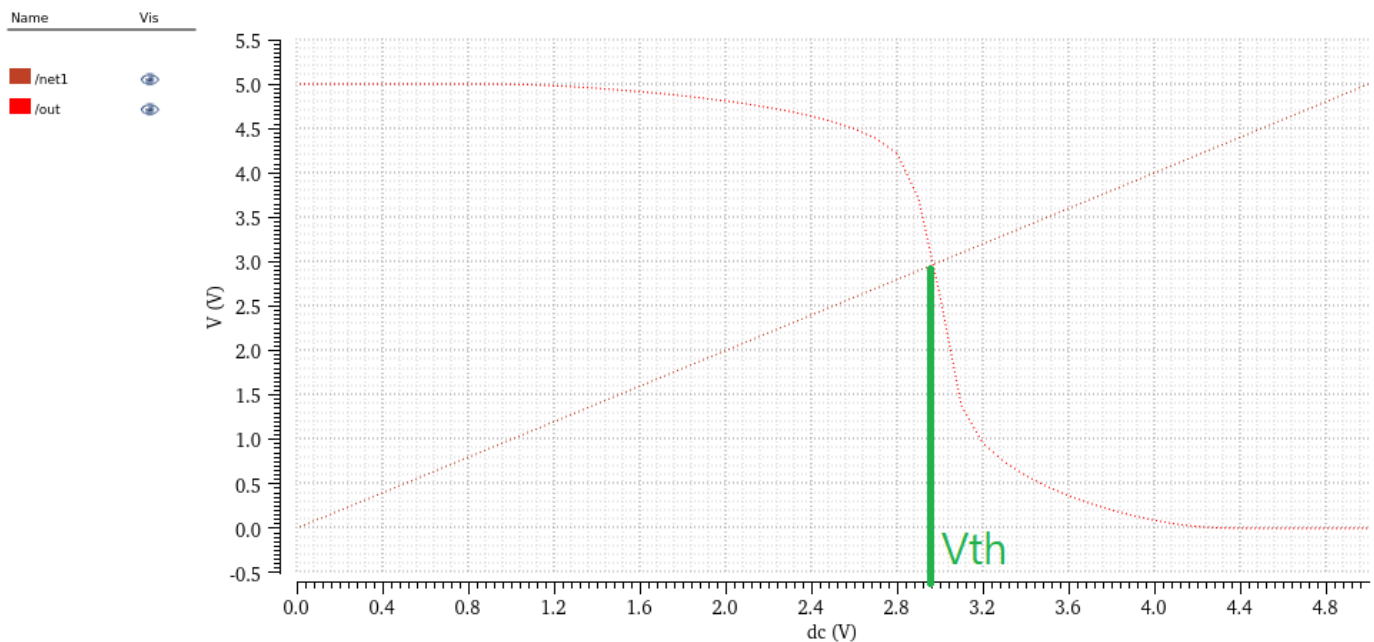
* Tested on extracted version

V_{th} : 2.96 V

t_{fall} : 207ps to reach the 500mV

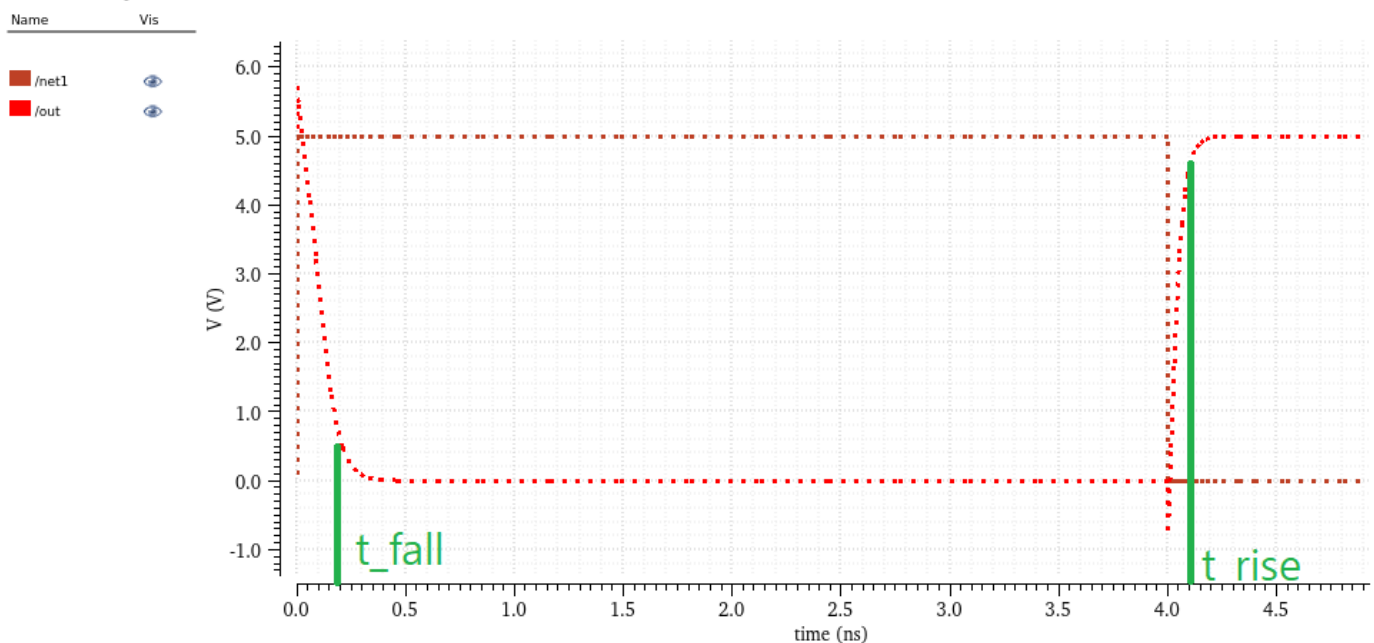
DC Response

Sun Mar 5 14:50:48 2023 1



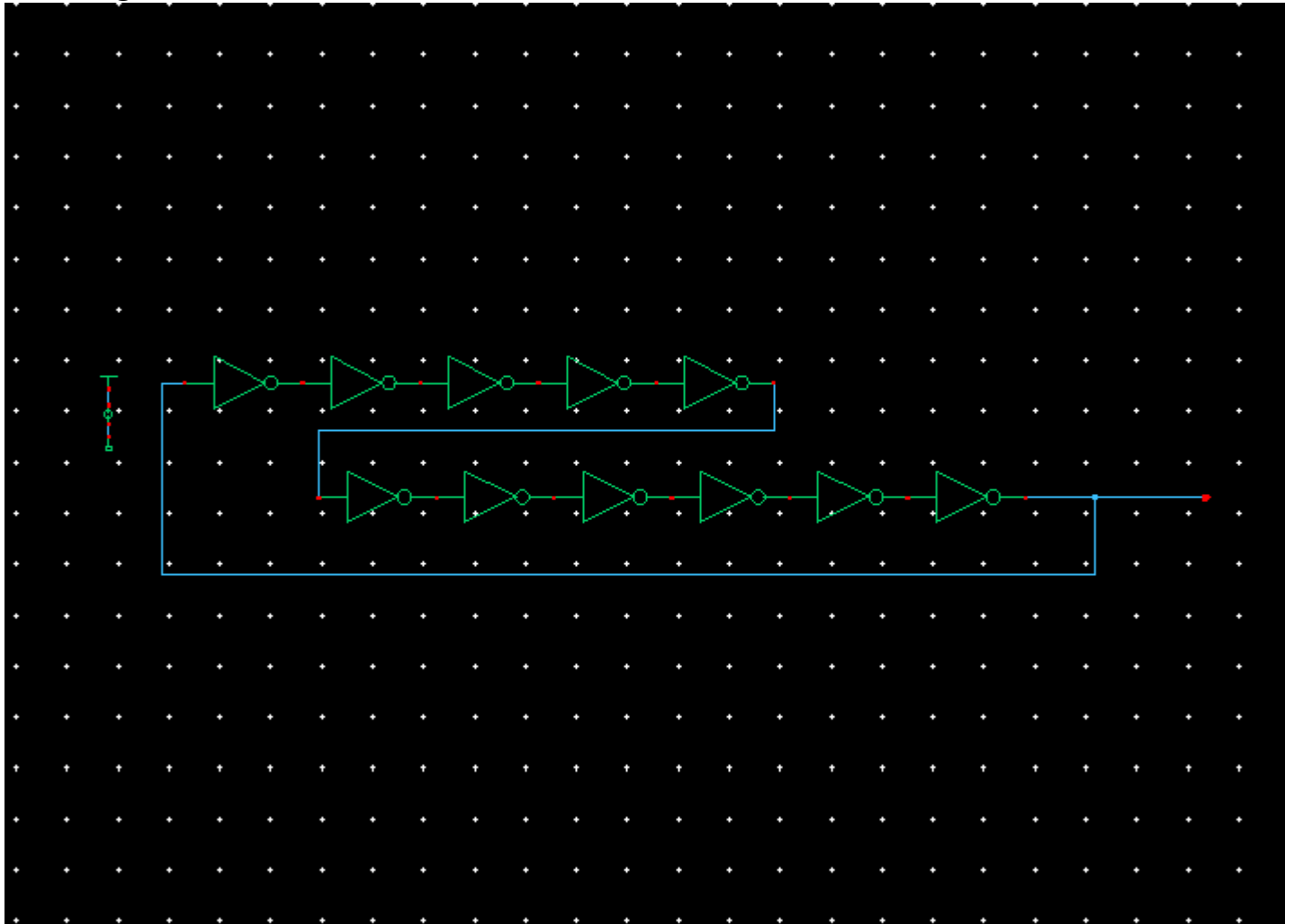
Transient Response

Sun Mar 5 14:51:28 2023 1

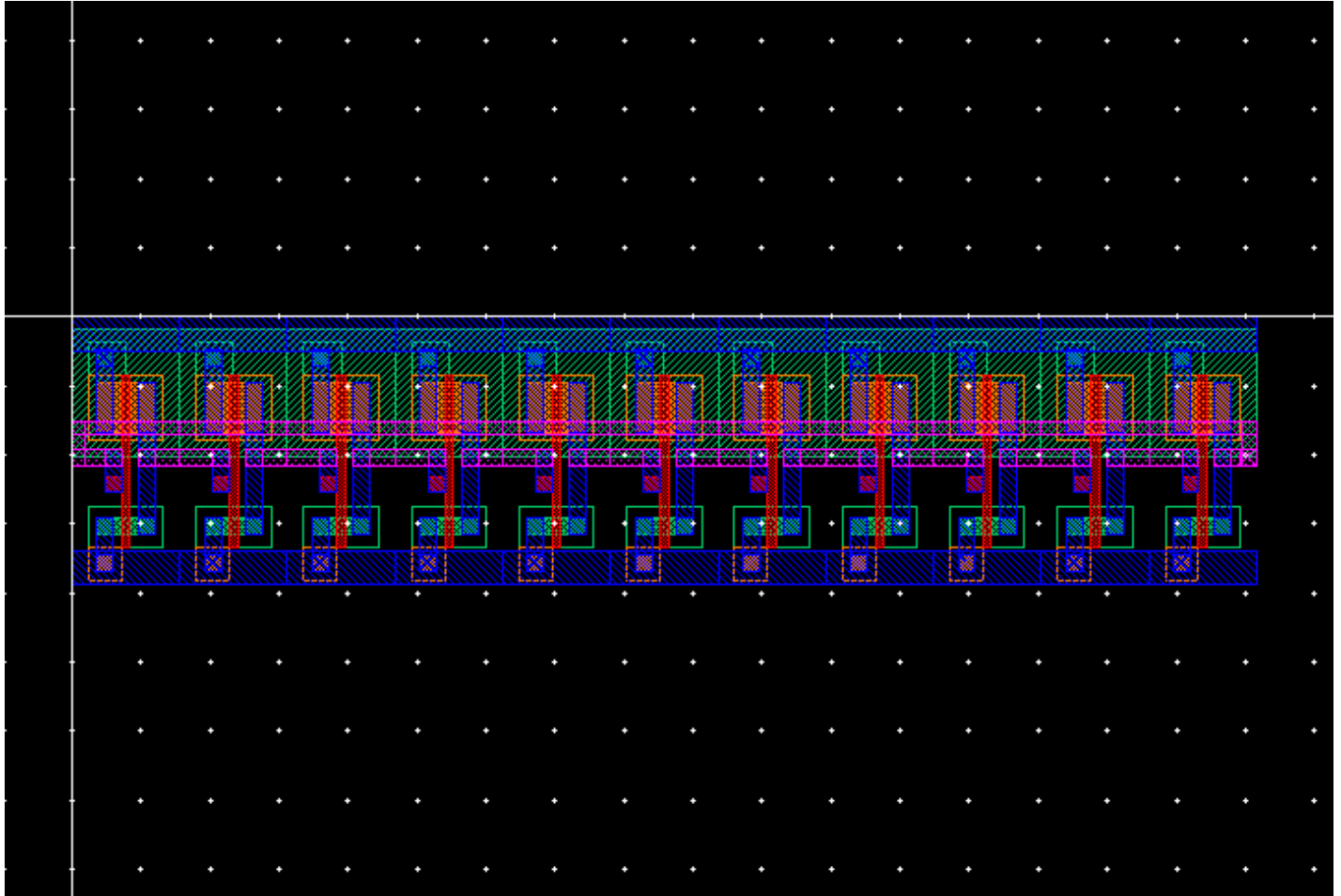


2)

+ 11 Ring oscillator schematic



+ 11 Ring oscillator layout



+ layout DRC check

Validating hierarchy instantiation for:

library: cse463

cell: inv_homework3_ring

view: layout

Rules come from library NCSU_TechLib_ami06.

Rules path is divaDRC.rul.

Inclusion limit is set to 1000.

Running layout DRC analysis

Flat mode

Full checking.

executing: nodrc = geomOr("nodrc")

executing: gwell = geomOr(geomAndNot(("gwell" "drawing") nodrc))

executing: nwell = geomOr(geomAndNot(("nwell" "drawing") nodrc))

executing: pwell = geomOr(geomAndNot(("pwell" "drawing") nodrc))

executing: nactive = geomOr(geomAndNot(("nactive" "drawing") nodrc))

executing: pactive = geomOr(geomAndNot(("pactive" "drawing") nodrc))

executing: active = geomOr(geomAndNot(("active" "drawing") nodrc) nactive pactive)

executing: gselect = geomOr(geomAndNot(("gselect" "drawing") nodrc))

executing: nselect = geomOr(geomAndNot(("nselect" "drawing") nodrc))

executing: pselect = geomOr(geomAndNot(("pselect" "drawing") nodrc))

executing: poly = geomOr(geomAndNot(("poly" "drawing") nodrc))

executing: metal1 = geomOr(geomAndNot(("metal1" "drawing") nodrc))

executing: cc = geomOr(geomAndNot(("cc" "drawing") nodrc))

executing: metal2 = geomOr(geomAndNot(("metal2" "drawing") nodrc))

executing: via = geomOr(geomAndNot(("via" "drawing") nodrc))

executing: glass = geomOr(geomAndNot(("glass" "drawing") nodrc))

executing: pad = geomOr(geomAndNot(("pad" "drawing") nodrc))

executing: res_id = geomOr("res_id")

```

executing: metal3 = geomOr(geomAndNot(("metal3" "drawing") nodrc))
executing: via2 = geomOr(geomAndNot(("via2" "drawing") nodrc))
executing: highres = geomOr(geomAndNot(("highres" "drawing") nodrc))
executing: elec = geomOr(geomAndNot(("elec" "drawing") nodrc))
executing: ce = geomOr(geomOr(geomAndNot(("ce" "drawing") nodrc)) geomAnd(cc elec))
executing: cp = geomOr(geomOr(geomAndNot(("cp" "drawing") nodrc)) geomAnd(cc geomAndNot(poly ce)))
executing: ca = geomOr(geomOr(geomAndNot(("ca" "drawing") nodrc)) geomAnd(cc geomAndNot(active ...
executing: nActive = geomAnd(active nselect)
executing: pActive = geomAnd(active pselect)
executing: nBulk = geomOr(nwell)
executing: pBulk = geomOr(geomNot(nwell) geomAndNot(pwell nwell))
executing: nOhmic = geomAnd(nActive nwell)
           nNotOhmic = geomAndNot(nActive nwell)
executing: pOhmic = geomAndNot(pActive nwell)
           pNotOhmic = geomAnd(pActive nwell)
executing: nDiff = geomAndNot(nNotOhmic geomOr(poly elec))
executing: pDiff = geomAndNot(pNotOhmic geomOr(poly elec))
executing: nDiffContact = geomAnd(ca nDiff)
executing: pDiffContact = geomAnd(ca pDiff)
executing: nOhmicContact = geomAnd(ca nOhmic)
executing: pOhmicContact = geomAnd(ca pOhmic)
executing: Gate = geomAnd(geomOr(nNotOhmic pNotOhmic) poly)
executing: fieldPoly = geomAvoiding(poly Gate)
executing: elecGate = geomAnd(geomOr(nNotOhmic pNotOhmic) elec)
executing: fieldElec = geomAvoiding(elec elecGate)
executing: CapacitorElec = geomInside(elec poly)
executing: TransistorElec = geomOverlap(elec geomNot(poly))
executing: fieldPoly = geomAndNot(fieldPoly res_id)
executing: poly = geomAndNot(poly res_id)
executing: fieldElec = geomAndNot(fieldElec geomOr(res_id highres))
executing: elecRes = geomButting(geomAnd(res_id elec) fieldElec (keep == 2))
executing: elecHighres = geomButting(geomAnd(highres elec) fieldElec (keep == 2))
executing: elec = geomAndNot(elec geomOr(res_id highres))
executing: nBulk = geomAndNot(nBulk res_id)
executing: nwell = geomAndNot(nwell res_id)
executing: geomConnect((via nOhmicContact nOhmic nwell nBulk metal1) (via pOhmicContact pOhmic ...
executing: dubiousData(("gwell" "drawing") "Improperly formed shape - gwell")
executing: dubiousData(("nwell" "drawing") "Improperly formed shape - nwell")
executing: dubiousData(("pwell" "drawing") "Improperly formed shape - pwell")
executing: dubiousData(("active" "drawing") "Improperly formed shape - active, nactive or pacti...
executing: dubiousData(("gselect" "drawing") "Improperly formed shape - gselect")
executing: dubiousData(("nselect" "drawing") "Improperly formed shape - nselect")
executing: dubiousData(("pselect" "drawing") "Improperly formed shape - pselect")
executing: dubiousData(("poly" "drawing") "Improperly formed shape - poly")
executing: dubiousData(("metal1" "drawing") "Improperly formed shape - metal1")
executing: dubiousData(("ca" "drawing") "Improperly formed shape - ca")
executing: dubiousData(("cp" "drawing") "Improperly formed shape - cp")
executing: dubiousData(("metal2" "drawing") "Improperly formed shape - metal2")
executing: dubiousData(("via" "drawing") "Improperly formed shape - via")
executing: dubiousData(("glass" "drawing") "Improperly formed shape - glass")
executing: saveDerived(geomGetNon45(gwell) "Non-Manhattan shape - gwell")
executing: saveDerived(geomGetNon45(nwell) "Non-Manhattan shape - nwell")
executing: saveDerived(geomGetNon45(pwell) "Non-Manhattan shape - pwell")
executing: saveDerived(geomGetNon45(active) "Non-Manhattan shape - active, nactive or pactive")
executing: saveDerived(geomGetNon45(gselect) "Non-Manhattan shape - gselect")
executing: saveDerived(geomGetNon45(nselect) "Non-Manhattan shape - nselect")
executing: saveDerived(geomGetNon45(pselect) "Non-Manhattan shape - pselect")
executing: saveDerived(geomGetNon45(poly) "Non-Manhattan shape - poly")
executing: saveDerived(geomGetNon45(metal1) "Non-Manhattan shape - metal1")
executing: saveDerived(geomGetNon45(ca) "Non-Manhattan shape - ca")
executing: saveDerived(geomGetNon45(cp) "Non-Manhattan shape - cp")
executing: saveDerived(geomGetNon45(metal2) "Non-Manhattan shape - metal2")
executing: saveDerived(geomGetNon45(via) "Non-Manhattan shape - via")
executing: saveDerived(geomGetNon45(glass) "Non-Manhattan shape - glass")
executing: offGrid(gwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(pwell gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(active gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(gselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(nselect gridRes "(SCMOS Inst) Edge not on grid")

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executing: offGrid(pselect gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(poly gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal1 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ca gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(cp gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(metal2 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(glass gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("metal3" "drawing") "Improperly formed shape - metal3")
executing: dubiousData(("via2" "drawing") "Improperly formed shape - via2")
executing: saveDerived(geomGetNon45(metal3) "Non-Manhattan shape - metal3")
executing: saveDerived(geomGetNon45(via2) "Non-Manhattan shape - via2")
executing: offGrid(metal3 gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(via2 gridRes "(SCMOS Inst) Edge not on grid")
executing: dubiousData(("elec" "drawing") "Improperly formed shape - elec")
executing: dubiousData(("ce" "drawing") "Improperly formed shape - ce")
executing: saveDerived(geomGetNon45(elec) "Non-Manhattan shape - elec")
executing: saveDerived(geomGetNon45(ce) "Non-Manhattan shape - ce")
executing: offGrid(elec gridRes "(SCMOS Inst) Edge not on grid")
executing: offGrid(ce gridRes "(SCMOS Inst) Edge not on grid")
executing: nwellEdge = geomGetEdge(nwell)
executing: pwellEdge = geomGetEdge(pwell)
executing: activeEdge = geomGetEdge(active)
executing: nselectEdge = geomGetEdge(nselect)
executing: pselectEdge = geomGetEdge(pselect)
executing: polyEdge = geomGetEdge(poly)
executing: metal1Edge = geomGetEdge(metal1)
executing: caEdge = geomGetEdge(ca)
executing: cpEdge = geomGetEdge(cp)
executing: metal2Edge = geomGetEdge(metal2)
executing: viaEdge = geomGetEdge(via)
executing: glassEdge = geomGetEdge(glass)
executing: highresEdge = geomGetEdge(highres)
executing: ceEdge = geomGetEdge(ce)
executing: metal3Edge = geomGetEdge(metal3)
executing: via2Edge = geomGetEdge(via2)
executing: nBulkEdge = geomGetEdge(nBulk)
executing: pBulkEdge = geomGetEdge(pBulk)
executing: nOhmicEdge = geomGetEdge(nOhmic)
executing: pOhmicEdge = geomGetEdge(pOhmic)
executing: nNotOhmicEdge = geomGetEdge(nNotOhmic)
executing: pNotOhmicEdge = geomGetEdge(pNotOhmic)
executing: GateEdge = geomGetEdge(Gate)
executing: fieldPolyEdge = geomGetEdge(fieldPoly)
executing: CapacitorElecEdge = geomGetEdge(CapacitorElec)
executing: TransistorElecEdge = geomGetEdge(TransistorElec)
executing: elecHighresEdge = geomGetEdge(elecRes coincident elec)
executing: saveDerived(geomAndNot(active geomOr(nselect pselect)) "(DBM Rule 1.1) Active must b...")
executing: saveDerived(geomAnd(poly nOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(poly pOhmic) "(DBM Rule 2.0) Poly cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec nOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(elec pOhmic) "(DBM Rule 2.1) Elec cannot overlap ohmic diffusion")
executing: saveDerived(geomAnd(pactive nselect) "(DBM Rule 3.1) Pactive and Nselect may not ove...")
executing: saveDerived(geomAnd(nactive pselect) "(DBM Rule 3.2) Nactive and Pselect may not ove...")
executing: saveDerived(geomAnd(active elec) "(DBM Rule 4.0, AMI 0.6um) Elec and active may not ...")
executing: drc(nwellEdge (width < (lambda * 12.0)) errMesg)
    drc(nwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(pwellEdge (width < (lambda * 12.0)) errMesg)
    drc(pwellEdge (notch < (lambda * 6.0)) errMesg)
executing: drc(nwell (sep < (lambda * 18.0)) diffNet errMesg)
    drc(nwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: drc(pwell (sep < (lambda * 18.0)) diffNet errMesg)
    drc(pwell (sep < (lambda * 6.0)) sameNet errMesg)
executing: saveDerived(geomAnd(nwell pwell) "(SCMOS Rule 1 note) n-wells and p-wells may not ov...")
executing: drc(activeEdge (width < (lambda * 3.0)) errMesg)
    drc(activeEdge (sep < (lambda * 3.0)) errMesg)
    drc(activeEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge nBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pNotOhmicEdge pBulkEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(pBulkEdge nNotOhmicEdge (enc < (lambda * 6.0)) errMesg)

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executing: drc(nBulkEdge pNotOhmicEdge (enc < (lambda * 6.0)) errMesg)
executing: drc(nBulkEdge nOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nOhmicEdge pBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pOhmicEdge nBulkEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(pBulkEdge pOhmicEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(nNotOhmicEdge pOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(pNotOhmicEdge nOhmicEdge ((0 < sep) < (lambda * 4.0)) errMesg)
executing: drc(polyEdge (width < (lambda * 2.0)) errMesg)
    drc(polyEdge (sep < (lambda * 3.0)) errMesg)
    drc(polyEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge activeEdge (enc < (lambda * 2.0)) errMesg)
    drc(activeEdge polyEdge (enc < (lambda * 3.0)) errMesg)
    drc(polyEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(nselectEdge geomGetEdge(polyEdge inside pNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(nselectEdge geomGetEdge(polyEdge inside nNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside nNotOhmic) (sep < (lambda * 3.0)) (app >...
executing: drc(pselectEdge geomGetEdge(polyEdge inside pNotOhmic) (enc < (lambda * 3.0)) (app >...
executing: drc(geomOr(nselectEdge pselectEdge) activeEdge (sep < (lambda * 2.0)) errMesg)
    drc(geomOr(nselectEdge pselectEdge) activeEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(nselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
    drc(nselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(pselectEdge caEdge (sep < (lambda * 1.0)) errMesg)
    drc(pselectEdge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomButting(geomAnd(ca nselect) geomAnd(ca pselect)) errMesg)
executing: drc(nselectEdge (width < (lambda * 2.0)) errMesg)
    drc(nselectEdge (sep < (lambda * 2.0)) errMesg)
    drc(nselectEdge (notch < (lambda * 2.0)) errMesg)
executing: drc(pselectEdge (width < (lambda * 2.0)) errMesg)
    drc(pselectEdge (sep < (lambda * 2.0)) errMesg)
    drc(pselectEdge (notch < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(nselect pselect) errMesg)
executing: drc(cpEdge (width < (lambda * 2.0)) errMesg)
    drc(cpEdge (sep < (lambda * 3.0)) errMesg)
    drc(cpEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(cp (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(polyEdge cpEdge (enc < (lambda * 1.0)) errMesg)
    drc(cpEdge polyEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(cp poly) errMesg)
executing: saveDerived(geomAndNot(cc geomOr(poly elec active)) errMesg)
executing: drc(cpEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(cpEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(cp active) errMesg)
executing: saveDerived(geomGetLength(drc(cpEdge activeEdge (sep < (lambda * 3.0))) (length > (...
executing: drc(caEdge (width < (lambda * 2.0)) errMesg)
    drc(caEdge (sep < (lambda * 3.0)) errMesg)
    drc(caEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ca (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(activeEdge caEdge (enc < (lambda * 1.0)) errMesg)
    drc(caEdge activeEdge (sep < (lambda * 5.0)) errMesg)
executing: saveDerived(geomAndNot(ca active) errMesg)
executing: drc(caEdge GateEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(ca Gate) errMesg)
executing: drc(caEdge fieldPolyEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(ca fieldPoly) errMesg)
executing: saveDerived(geomGetLength(drc(caEdge fieldPolyEdge (sep < (lambda * 3.0))) (length >...
executing: drc(caEdge cpEdge (sep < (lambda * 4.0)) errMesg)
executing: saveDerived(geomAnd(ca cp) errMesg)
executing: drc(metal1Edge (width < (lambda * 3.0)) errMesg)
    drc(metal1Edge (sep < (lambda * 3.0)) errMesg)
    drc(metal1Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal1Edge cpEdge (enc < (lambda * 1.0)) errMesg)
executing: drc(metal1Edge caEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(cp metal1) errMesg)
executing: saveDerived(geomAndNot(ca metal1) errMesg)
executing: drc(viaEdge (width < (lambda * 2.0)) errMesg)
    drc(viaEdge (sep < (lambda * 3.0)) errMesg)
executing: drc(via (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1))))...
executing: drc(metal1Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal1) errMesg)
executing: drc(metal2Edge (width < (lambda * 3.0)) errMesg)

```

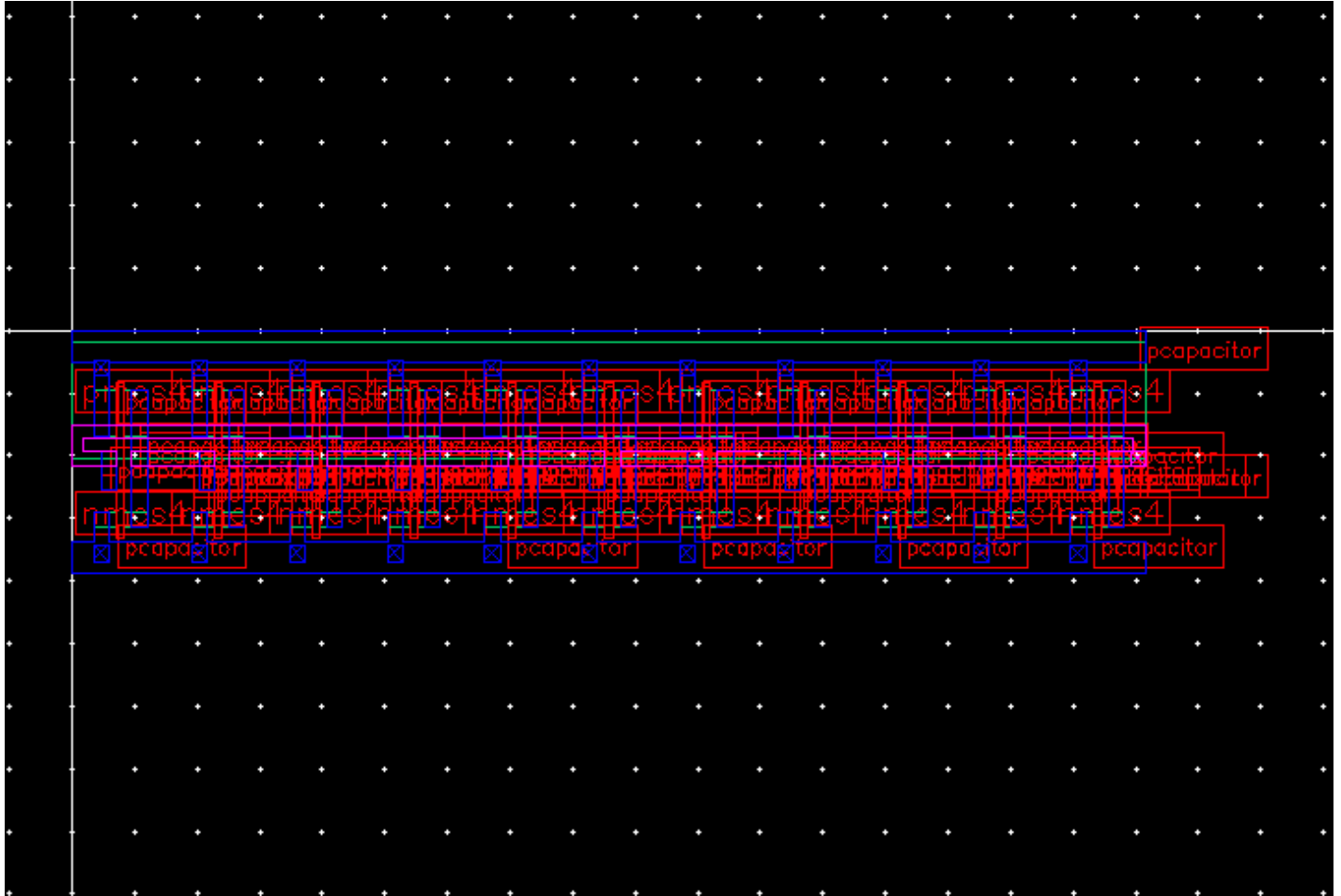
```

    drc(metal2Edge (sep < (lambda * 3.0)) errMesg)
    drc(metal2Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal2Edge viaEdge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via metal2) errMesg)
executing: BondingGlass = geomInside(glass pad)
    ProbeGlass = geomOutside(glass pad)
executing: saveDerived(geomStraddle(glass pad))
executing: BondingPad = geomAndNot(geomSize(BondingGlass 6.0) geomHoles(BondingGlass))
executing: ProbePad = geomAndNot(geomSize(ProbeGlass 6.0) geomHoles(ProbeGlass))
executing: Pad = geomOr(BondingPad ProbePad)
executing: BondingPadEdge = geomGetEdge(BondingPad not_over "nodrc")
executing: ProbePadEdge = geomGetEdge(ProbePad not_over "nodrc")
executing: PadEdge = geomGetEdge(Pad not_over "nodrc")
executing: Metal3EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal3" "glass" 36.0)) not_ov...
executing: Metal2EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal2" "glass" 36.0)) not_ov...
executing: Metal1EdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("metal1" "glass" 21.0)) not_ov...
executing: PolyEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("poly" "glass" 21.0)) not_over "...
executing: ActiveEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("active" "glass" 21.0)) not_ov...
executing: ElecEdgeNearPad = geomGetEdge(geomOr(geomGetByLayer("elec" "glass" 21.0)) not_over "...
executing: drc(BondingPadEdge (width < 60.0) "(SCMOS Rule 10.1) bonding pad width: 60 um")
executing: drc(ProbePadEdge (width < 20.0) "(SCMOS Rule 10.2) probe pad width: 20 um")
executing: drc(Metal3EdgeNearPad glassEdge (enc < 6.0) "(SCMOS Rule 10.3) pad enclosure of glas...
executing: saveDerived(geomAndNot(glass metal3) "(SCMOS Rule 10.3) pad enclosure of glass: 6 um")
executing: drc(PadEdge Metal3EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal2EdgeNearPad (sep < 30.0) "(SCMOS Rule 10.4) pad to unrelated metal...
executing: drc(PadEdge Metal1EdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated metal...
executing: drc(PadEdge PolyEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated poly sp...
executing: drc(PadEdge ActiveEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated activ...
executing: drc(PadEdge ElecEdgeNearPad (sep < 15.0) "(SCMOS Rule 10.5) pad to unrelated elec sp...
executing: drc(CapacitorElecEdge (width < (lambda * 7.0)) errMesg)
    drc(CapacitorElecEdge (sep < (lambda * 3.0)) errMesg)
    drc(CapacitorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(polyEdge CapacitorElecEdge (enc < (lambda * 5.0)) errMesg)
executing: drc(CapacitorElecEdge nBulkEdge (sep < (lambda * 2.0)) errMesg)
    drc(nBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: drc(CapacitorElecEdge pBulkEdge (sep < (lambda * 2.0)) errMesg)
    drc(pBulkEdge CapacitorElecEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec nBulk) errMesg)
executing: saveDerived(geomStraddle(CapacitorElec pBulk) errMesg)
executing: drc(CapacitorElecEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(CapacitorElec active) errMesg)
executing: drc(CapacitorElecEdge cpEdge (sep < (lambda * 6.0)) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal3") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal3 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal2") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal2 elec diffNet) errMesg)
executing: drc(geomGetEdge("elec") geomGetEdge("metal1") (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomOverlap(metal1 elec diffNet) errMesg)
executing: drc(TransistorElecEdge (width < (lambda * 2.0)) errMesg)
    drc(TransistorElecEdge (sep < (lambda * 3.0)) errMesg)
    drc(TransistorElecEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge activeEdge (enc < (lambda * 2.0)) errMesg)
    drc(TransistorElecEdge activeEdge (sep < (lambda * 1.0)) errMesg)
executing: drc(TransistorElecEdge polyEdge (sep < (lambda * 2.0)) errMesg)
    drc(TransistorElecEdge polyEdge (ovlp < (lambda * 2.0)) errMesg)
executing: drc(TransistorElecEdge cpEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec cp) errMesg)
executing: drc(TransistorElecEdge caEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(TransistorElec ca) errMesg)
executing: drc(ceEdge (width < (lambda * 2.0)) errMesg)
    drc(ceEdge (sep < (lambda * 3.0)) errMesg)
    drc(ceEdge (notch < (lambda * 3.0)) errMesg)
executing: drc(ce (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))) ...
executing: drc(CapacitorElecEdge ceEdge (enc < (lambda * 3.0)) errMesg)
executing: drc(TransistorElecEdge ceEdge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(ce elec) "(SCMOS Rules 13.3,13.4) electrode enclosure of cont...
executing: drc(ceEdge polyEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomOutside(geomAnd(ce poly) CapacitorElec) errMesg)
executing: drc(ceEdge activeEdge (sep < (lambda * 3.0)) errMesg)
executing: saveDerived(geomAnd(ce active) errMesg)

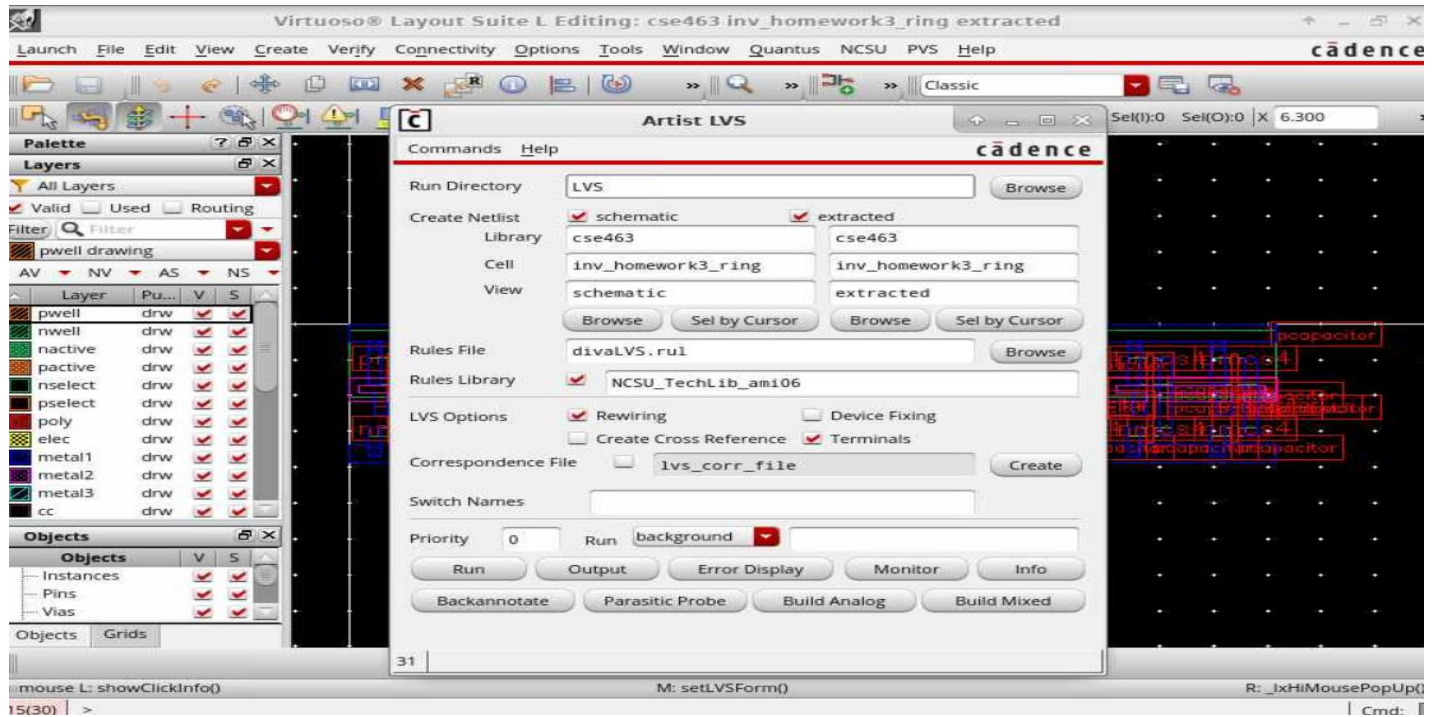
```

```
executing: drc(via2Edge (width < (lambda * 2.0)) errMesg)
    drc(via2Edge (sep < (lambda * 3.0)) errMesg)
executing: drc(via2 (area > ((lambda * 2.0 * (lambda * 2.0)) + (lambda * 0.1 * (lambda * 0.1)))...
executing: drc(metal2Edge via2Edge (enc < (lambda * 1.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal2) errMesg)
executing: drc(metal3Edge (width < (lambda * 5.0)) errMesg)
    drc(metal3Edge (sep < (lambda * 3.0)) errMesg)
    drc(metal3Edge (notch < (lambda * 3.0)) errMesg)
executing: drc(metal3Edge via2Edge (enc < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAndNot(via2 metal3) errMesg)
executing: drc(highresEdge (width < (lambda * 4.0)) errMesg)
    drc(highresEdge (sep < (lambda * 4.0)) errMesg)
    drc(highresEdge (notch < (lambda * 4.0)) errMesg)
executing: drc(highresEdge caEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge cpEdge (sep < (lambda * 2.0)) errMesg)
executing: saveDerived(geomAnd(highres ca) errMesg)
executing: saveDerived(geomAnd(highres cp) errMesg)
executing: drc(highresEdge activeEdge (sep < (lambda * 2.0)) errMesg)
executing: drc(highresEdge geomGetEdge(geomAndNot(elec geomButting(elec elecHighres))) (sep < (...
executing: saveDerived(geomButting(elecHighres geomAndNot(elec elecHighres) (ignore == 2)) errM...
executing: saveDerived(geomAnd(elecHighres nwell) "(SCMOS Rule 27.6) resistor must be outside w...
executing: saveDerived(geomAnd(elecHighres active) "(SCMOS Rule 27.6) resistor must be outside ...
executing: drc(elecHighresEdge (width < (lambda * 5.0)) errMesg)
    drc(elecHighresEdge (sep < (lambda * 7.0)) errMesg)
    drc(elecHighresEdge (notch < (lambda * 7.0)) errMesg)
executing: drc(highresEdge elecHighresEdge (enc < (lambda * 2.0)) errMesg)
DRC started.....Mon Mar 6 22:36:54 2023
completed ....Mon Mar 6 22:36:54 2023
CPU TIME = 00:00:00 TOTAL TIME = 00:00:00
***** Summary of rule violations for cell "inv_homework3_ring layout" *****
Total errors found: 0
```

+ 11 Ring oscillator extracted



+ extracted LVS check



@(#)SCDS: LVS version 6.1.8-64b 08/09/2022 19:10 (sjfhw317) \$

Command line: /project/engineering/cadence21/IC618/tools.lnx86/dfl/bin/64bit/LVS -dir /home/warehouse/b.gwak/cadence/LVS -l -s -t /home/warehouse/b.gwak/cadence/LVS/layout /home/warehouse/b.gwak/cadence/LVS/schematic

Like matching is enabled.

Net swapping is enabled.

Using terminal names as correspondence points.

Compiling Diva LVS rules...

Net-list summary for /home/warehouse/b.gwak/cadence/LVS/layout/netlist

count	
13	nets
3	terminals
11	pmos
11	nmos

Net-list summary for /home/warehouse/b.gwak/cadence/LVS/schematic/netlist

count	
13	nets
3	terminals
11	pmos
11	nmos

Terminal correspondence points

N11	N8	OUT
N10	N0	gnd!
N12	N1	vdd!

Devices in the netlist but not in the rules:

pcapacitor

Devices in the rules but not in the netlist:

cap nfet pfet nmos4 pmos4

The net-lists match.

	layout	schematic
instances		
un-matched	0	0
rewired	0	0
size errors	0	0
pruned	0	0
active	22	22
total	22	22

nets		
un-matched	0	0
merged	0	0
pruned	0	0
active	13	13
total	13	13

terminals		
un-matched	0	0
matched but		
different type	0	0
total	3	3

Probe files from /home/warehouse/b.gwak/cadence/LVS/schematic

devbad.out:

netbad.out:

mergenet.out:

termbad.out:

prunenet.out:

prunedev.out:

audit.out:

Probe files from /home/warehouse/b.gwak/cadence/LVS/layout

devbad.out:

netbad.out:

mergenet.out:

termbad.out:

prunenet.out:

prunedev.out:

audit.out:

+ Test(extracted)

```
// Generated for: spectre
// Generated on: Mar 6 22:39:35 2023
// Design library name: cse463
// Design cell name: inv_homework3_ring
// Design view name: schematic
simulator lang=spectre
global 0 vdd!
include "/project/linuxlab/cadence/CDK/ncsu/models/spectre/nom/ami06N.m"
include "/project/linuxlab/cadence/CDK/ncsu/models/spectre/nom/ami06P.m"

// Library name: cse463
// Cell name: inv_homework3
// View name: extracted
// View type: maskLayout
subckt inv_homework3_extracted in out
  \+1 (out in vdd! vdd!) ami06P w=3.6e-06 l=6e-07 as=6.48e-12 \
    ad=6.48e-12 ps=7.2e-06 pd=7.2e-06 m=1 region=sat
  \+15 (in 0) capacitor c=4.2687e-16 m=1
  \+14 (in vdd!) capacitor c=1.3392e-16 m=1
  \+13 (vdd! 0) capacitor c=1.59252e-15 m=1
  \+12 (out 0) capacitor c=9.5022e-16 m=1
  \+11 (out vdd!) capacitor c=4.4736e-16 m=1
  \+10 (in 0) capacitor c=4.4736e-16 m=1
  \+9 (in vdd!) capacitor c=2.7354e-16 m=1
  \+8 (vdd! 5) capacitor c=9.0675e-16 m=1
  \+7 (out 5) capacitor c=2.8407e-16 m=1
  \+6 (out 0) capacitor c=2.4585e-16 m=1
  \+5 (out vdd!) capacitor c=2.1951e-16 m=1
  \+4 (in 5) capacitor c=1.5288e-16 m=1
  \+3 (in 0) capacitor c=3.153e-16 m=1
  \+2 (in vdd!) capacitor c=2.8518e-16 m=1
  \+0 (out in 0 0) ami06N w=1.2e-06 l=6e-07 as=2.16e-12 ad=2.16e-12 \
    ps=4.8e-06 pd=4.8e-06 m=1 region=sat
ends inv_homework3_extracted
// End of subcircuit definition.

// Library name: cse463
// Cell name: inv_homework3_ring
// View name: schematic
I34 (net1 net4) inv_homework3_extracted
I33 (net7 net1) inv_homework3_extracted
I32 (net10 net7) inv_homework3_extracted
```

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I31 (net8 net9) inv_homework3_extracted
I30 (net9 OUT) inv_homework3_extracted
I29 (net4 net8) inv_homework3_extracted
I27 (net6 net10) inv_homework3_extracted
I26 (net5 net6) inv_homework3_extracted
I11 (net3 net5) inv_homework3_extracted
I9 (net2 net3) inv_homework3_extracted
I6 (OUT net2) inv_homework3_extracted
V1 (vdd! 0) vsource type=dc dc=5
ic OUT=0
simulatorOptions options psfversion="1.4.0" reltol=1e-3 vabstol=1e-6 \
  iabstol=1e-12 temp=27 tnom=27 scalem=1.0 scale=1.0 gmin=1e-12 rforce=1 \
  maxnotes=5 maxwarns=5 digits=5 cols=80 pivrel=1e-3 \
  sensfile="./psf/sens.output" checklimitdest=psf
tran tran stop=80n write="spectre.ic" writefinal="spectre.fc" \
  annotate=status maxiters=5
finalTimeOP info what=oppoint where=rawfile
modelParameter info what=models where=rawfile
element info what=inst where=rawfile
outputParameter info what=output where=rawfile
designParamVals info what=parameters where=rawfile
primitives info what=primitives where=rawfile
subckts info what=subckts where=rawfile
saveOptions options save=allpub

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+ 11 Ring oscillator test

Transient Response

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