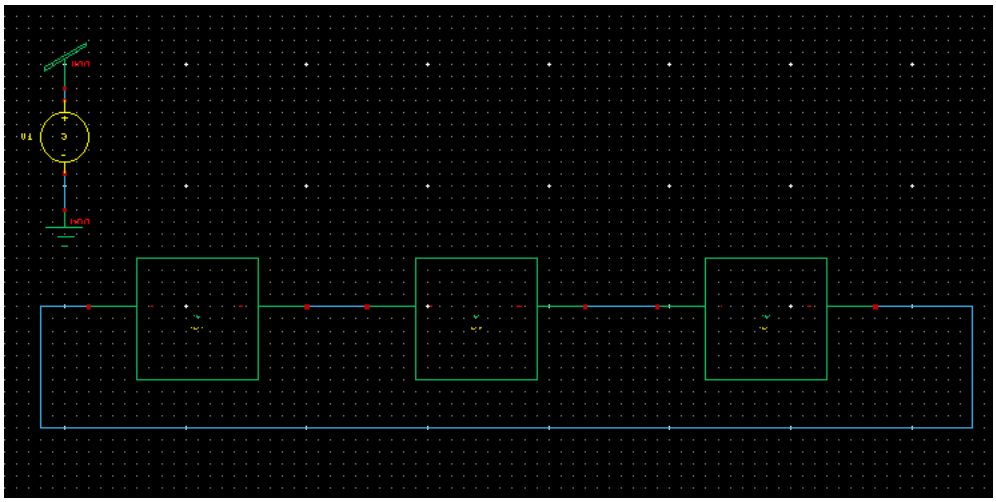
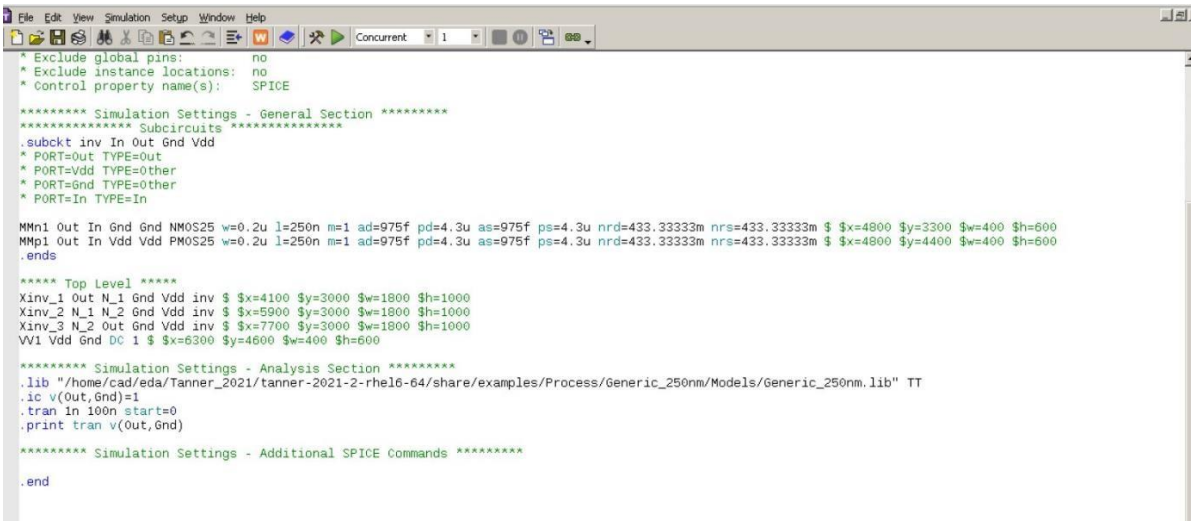
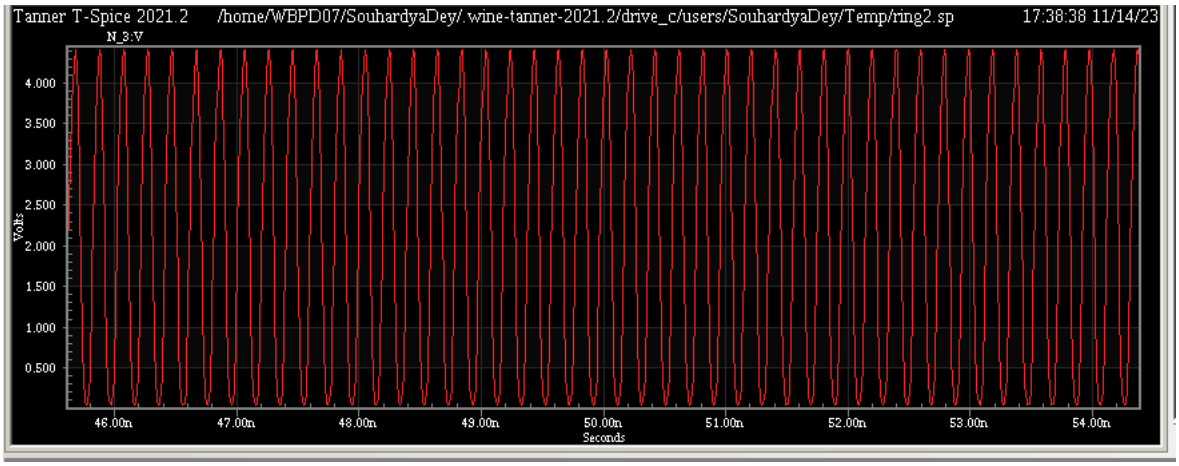
RING OSCILLATOR

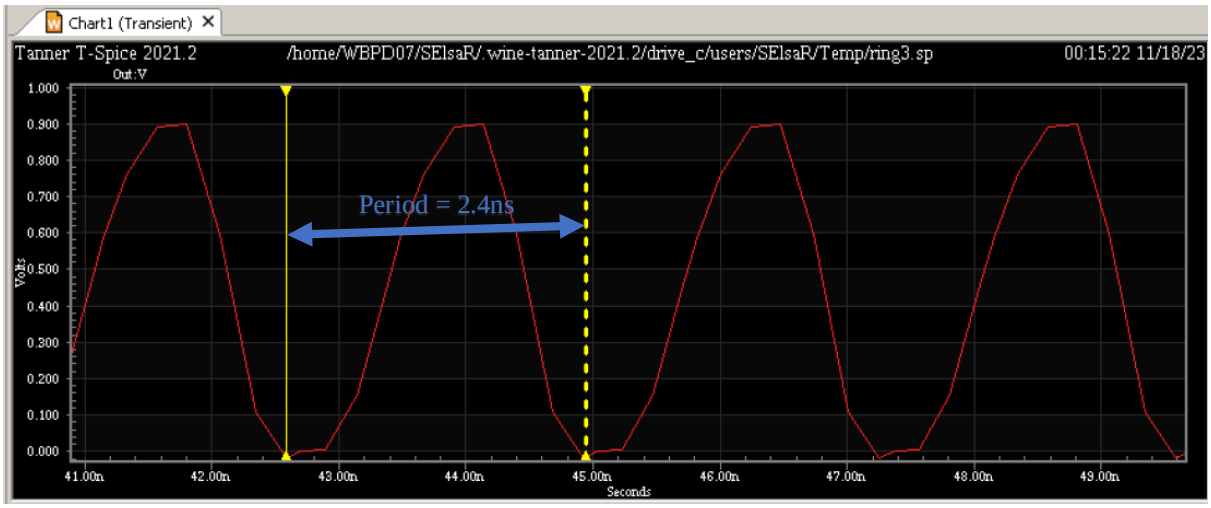







```
Power Results

VV1 from time 0 to 1e-09
Average power consumed -> 6.678350e-03 watts
Max power 9.266078e-03 at time 6.25e-11
Min power 5.572444e-03 at time 3.85959e-10
```

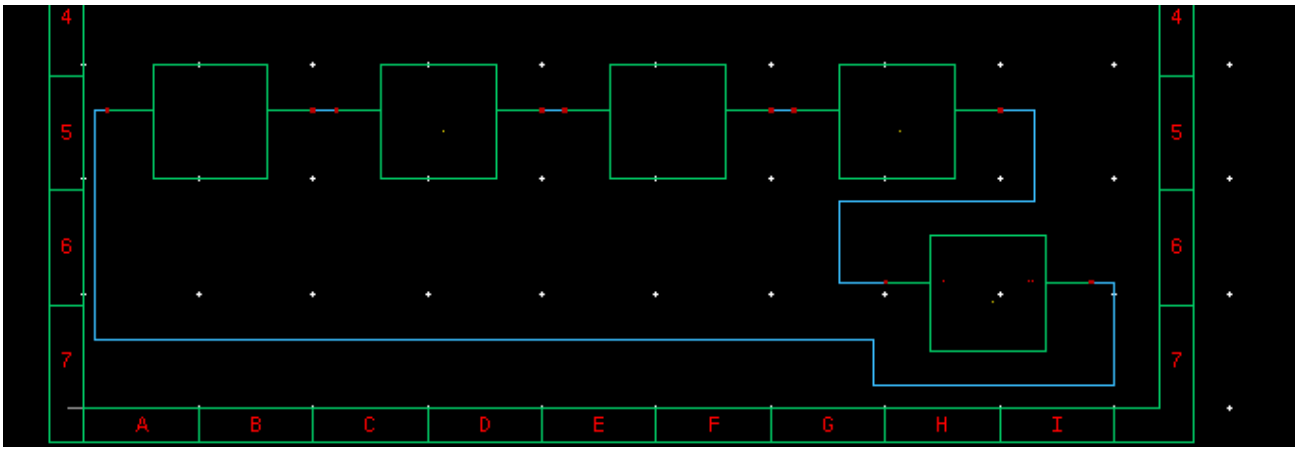
```
   Opening simulation database "/home/WBPD07/SouhardyaDey/.wine-tanner-2021

Parsing                      0.34 seconds
Setup                        0.05 seconds
Transient Analysis          17.18 seconds
Output                       1.25 seconds
-----------------------------------------
Total                       18.01 seconds

Simulation completed
```



Frequency = 1/Period = 1/(45 - 42.6) = 1/(2.4) = 416MHz

A) 5 – STAGE RING OSCILLATOR

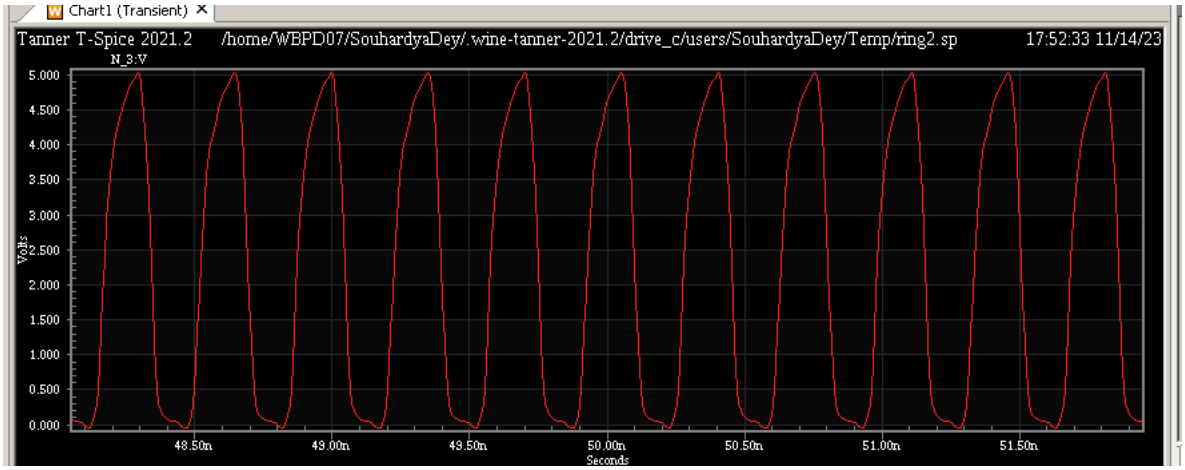
1. SCHEMATIC



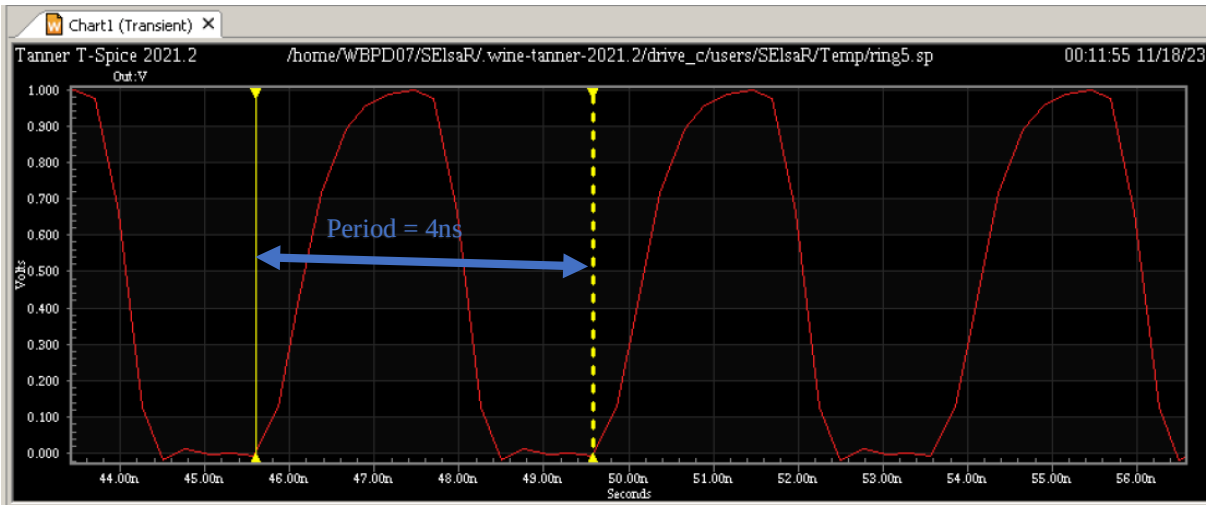
File Edit View Simulation Setup Window Help

Concurrent 1

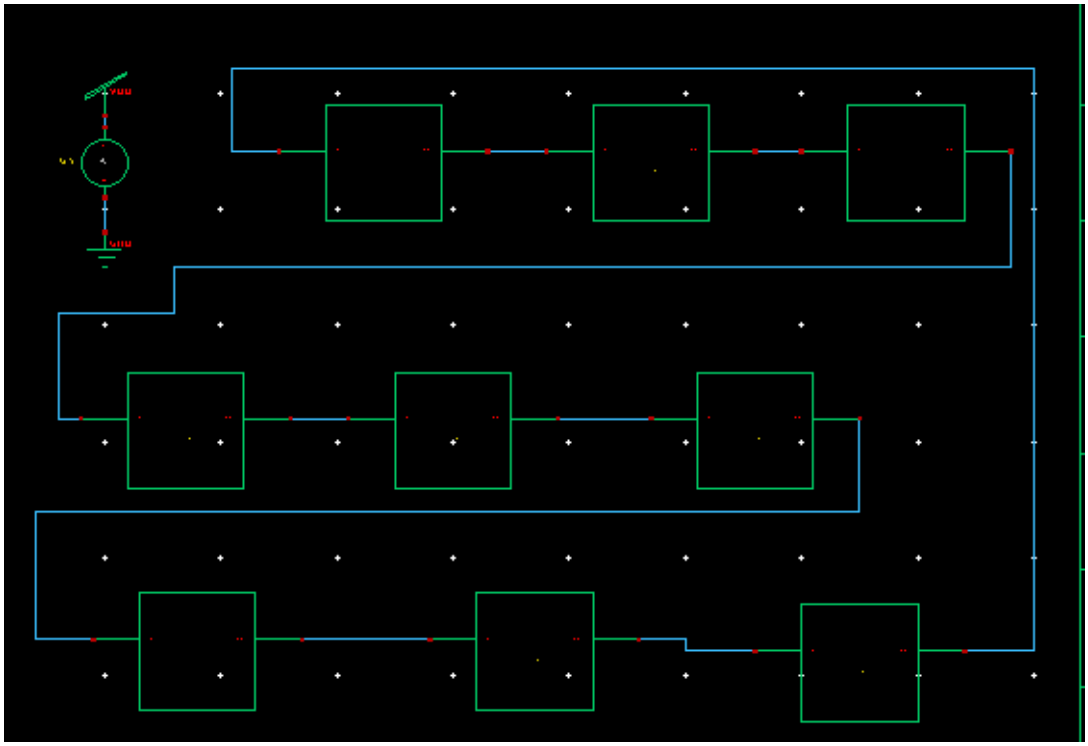
```
* Exclude global pins:          no
* Exclude instance locations:   no
* Control property name(s):     SPICE

********* Simulation Settings - General Section *********
*************** Subcircuits ***************
.subckt inv In Out Gnd Vdd
* PORT=Out TYPE=Out
* PORT=Vdd TYPE=Other
* PORT=Gnd TYPE=Other
* PORT=In TYPE=In

MMn1 Out In Gnd Gnd NMOS25 w=0.2u l=250n m=1 ad=975f pd=4.3u as=975f ps=4.3u nrd=433.33333m nrs=433.33333m $ $x=4800 $y=3300 $w=400 $h=600
MMp1 Out In Vdd Vdd PMOS25 w=0.2u l=250n m=1 ad=975f pd=4.3u as=975f ps=4.3u nrd=433.33333m nrs=433.33333m $ $x=4800 $y=4400 $w=400 $h=600
.ends


***** Top Level *****
Xinv_1 Out N_1 Gnd Vdd inv $ $x=1200 $y=3900 $w=1800 $h=1000
Xinv_2 N_1 N_2 Gnd Vdd inv $ $x=3000 $y=3900 $w=1800 $h=1000
Xinv_3 N_2 N_3 Gnd Vdd inv $ $x=4800 $y=3900 $w=1800 $h=1000
Xinv_4 N_3 N_4 Gnd Vdd inv $ $x=6600 $y=3900 $w=1800 $h=1000
Xinv_5 N_4 Out Gnd Vdd inv $ $x=8400 $y=3900 $w=1800 $h=1000
VV1 Vdd Gnd DC 1 $ $x=6000 $y=6100 $w=400 $h=600

********* Simulation Settings - Analysis Section *********
.lib "/home/cad/eda/Tanner_2021/tanner-2021-2-rhel6-64/share/examples/Process/Generic_250nm/Models/Generic_250nm.lib" TT
.ic v(Out,Gnd)=1
.tran 1n 100n start=0
.print tran v(Out,Gnd)
********* Simulation Settings - Additional SPICE Commands *********

.end
```




```
Power Results

VV1 from time 0 to 1e-09
Average power consumed -> 6.922739e-03 watts
Max power 1.239218e-02 at time 6.25e-11
Min power 5.459304e-03 at time 3.11815e-10
```



Frequency = 1/Period = 1/(49.5 - 45.5) = 1/(4) = 250MHz

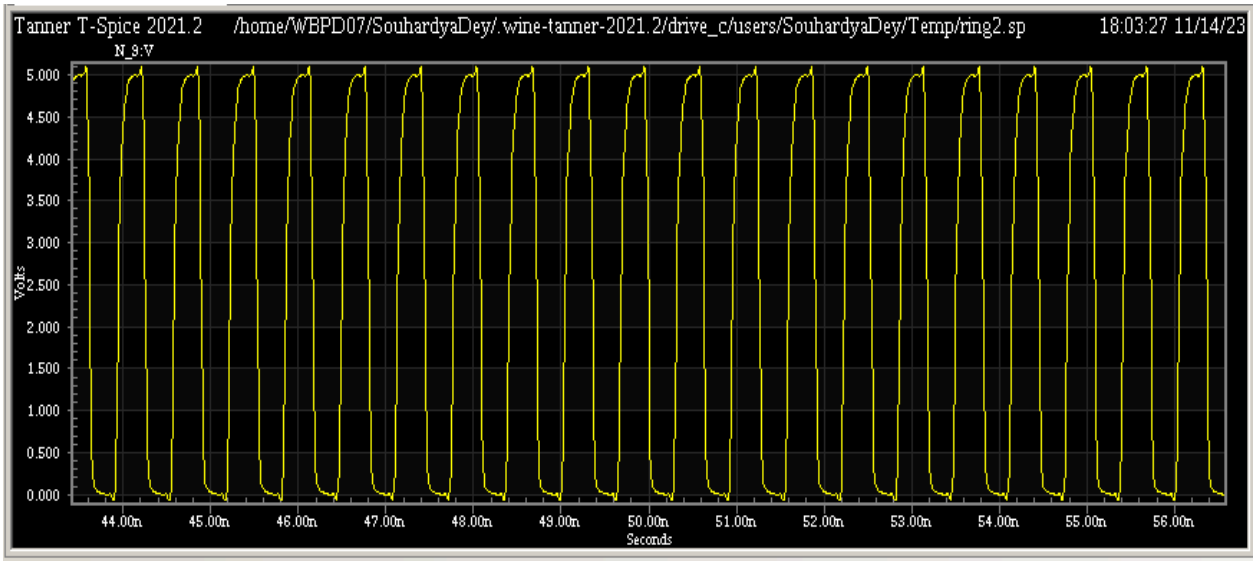


T-Spice 2021.2 - [ring9.sp *]

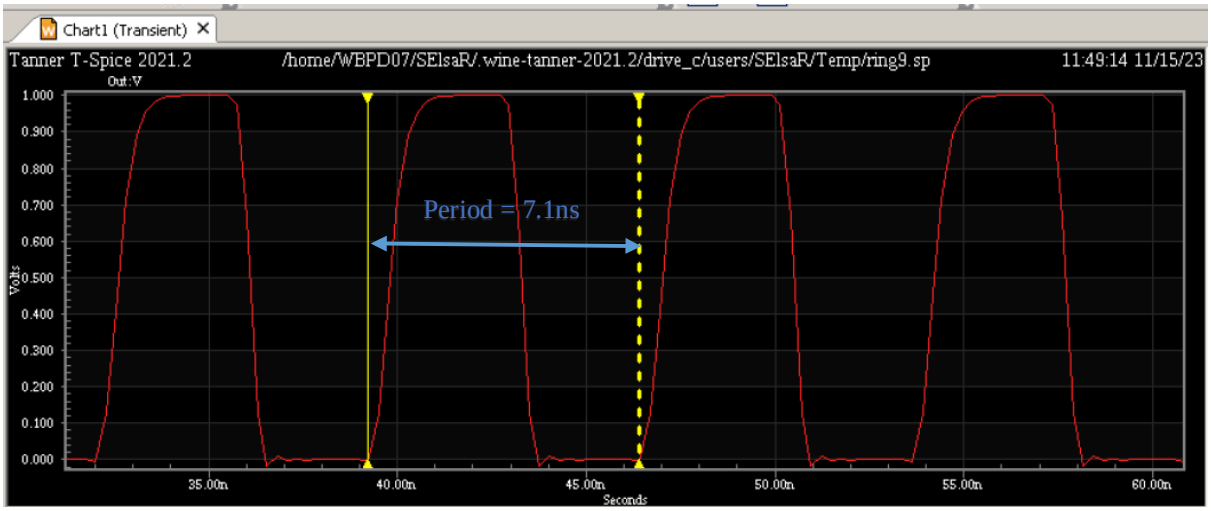
File Edit View Simulation Setup Window Help

Concurrent 1

```
********* Simulation Settings - General Section *********
*************** Subcircuits ***************
.subckt inv In Out Gnd Vdd
* PORT=Out TYPE=Out
* PORT=Vdd TYPE=Other
* PORT=Gnd TYPE=Other
* PORT=In TYPE=In

MMn1 Out In Gnd Gnd NMOS25 w=0.2u l=250n m=1 ad=975f pd=4.3u as=975f ps=4.3u nrd=433.33333m nrs=433.33333m $ $x=4800 $y=3300 $w=400 $h=600
MMp1 Out In Vdd Vdd PMOS25 w=0.2u l=250n m=1 ad=975f pd=4.3u as=975f ps=4.3u nrd=433.33333m nrs=433.33333m $ $x=4800 $y=4400 $w=400 $h=600
.ends


***** Top Level *****
Xinv_1 Out N_1 Gnd Vdd inv $ $x=1100 $y=4100 $w=1800 $h=1000
Xinv_2 N_1 N_2 Gnd Vdd inv $ $x=2900 $y=4100 $w=1800 $h=1000
Xinv_3 N_2 N_3 Gnd Vdd inv $ $x=4700 $y=4100 $w=1800 $h=1000
Xinv_4 N_3 N_4 Gnd Vdd inv $ $x=6500 $y=4100 $w=1800 $h=1000
Xinv_5 N_4 N_5 Gnd Vdd inv $ $x=8300 $y=4100 $w=1800 $h=1000
Xinv_6 N_5 N_6 Gnd Vdd inv $ $x=10100 $y=4100 $w=1800 $h=1000
Xinv_7 N_6 N_7 Gnd Vdd inv $ $x=11900 $y=4100 $w=1800 $h=1000
Xinv_8 N_7 N_8 Gnd Vdd inv $ $x=13700 $y=4100 $w=1800 $h=1000
Xinv_9 N_8 Out Gnd Vdd inv $ $x=15500 $y=4100 $w=1800 $h=1000
VV1 Vdd Gnd DC 1 $ $x=17000 $y=2400 $w=400 $h=600

********* Simulation Settings - Analysis Section *********
.lib "/home/cad/eda/Tanner_2021/tanner-2021-2-rhel6-64/share/examples/Process/Generic_250nm/Models/Generic_250nm.lib" TT
.ic v(Out,Gnd)=1
.tran 1n 100n start=0
.print tran v(Out,Gnd)

********* Simulation Settings - Additional SPICE Commands *********

.end
```



```
Power Results

VV1 from time 0 to 1e-09
Average power consumed -> 6.924189e-03 watts
Max power 1.239957e-02 at time 6.25e-11
Min power 5.488856e-03 at time 3.16148e-10
```



Frequency = 1/Period = 1/(46.3 - 39.2) = 1/(7.1) = 140MHz