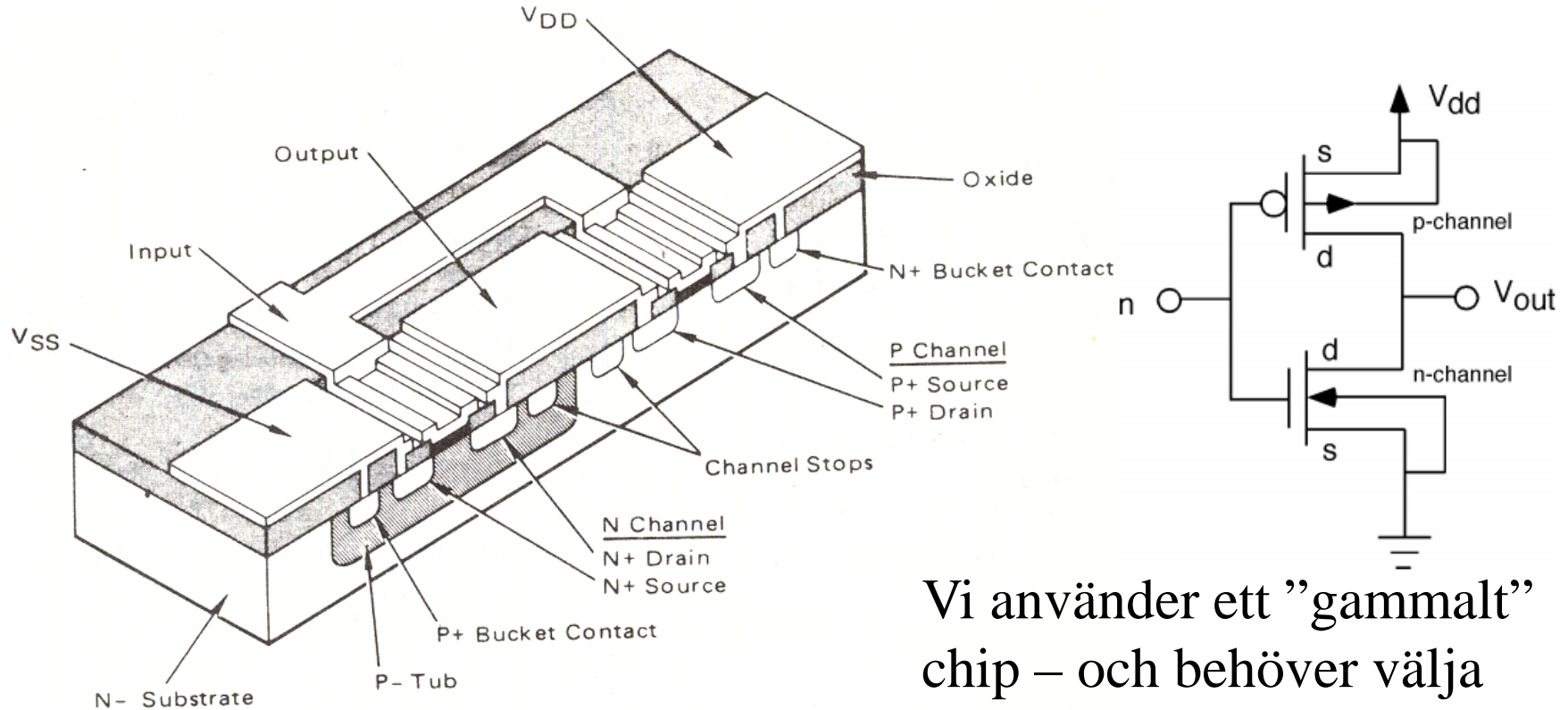


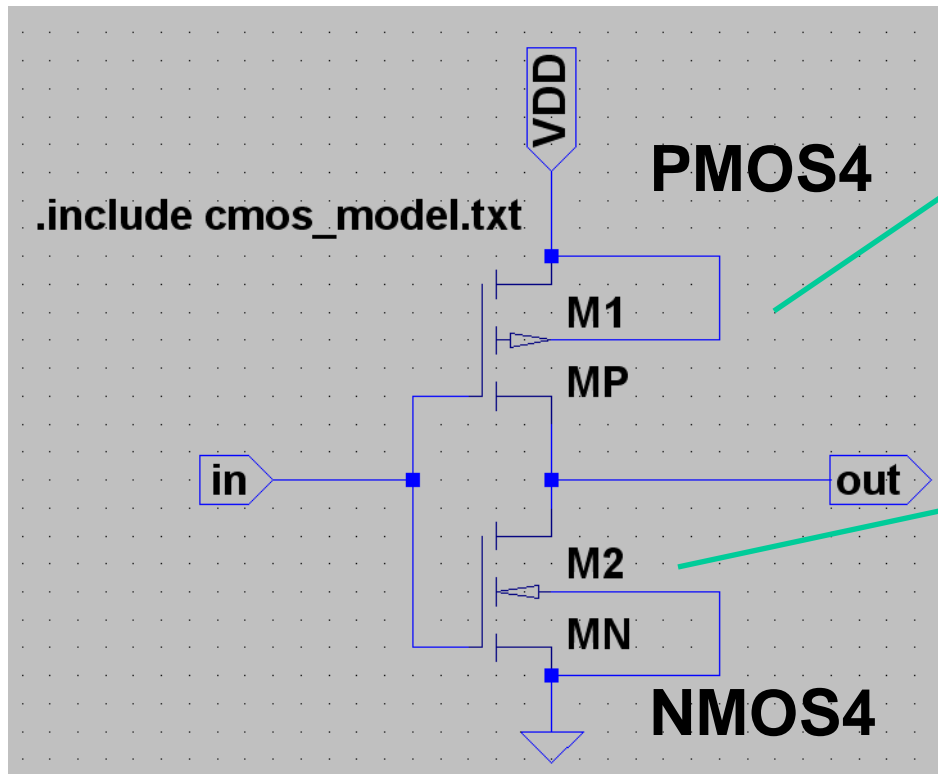
CMOS-inverterare



- *Kommer Du ihåg inverteraren från Digital Design kursen?*

Vi använder ett "gammalt" chip – och behöver välja tillverkningsparametrarna därefter!

MOS-Old school



Monolithic MOSFET - M1

Model Name: MP

Length(L): 5u

Width(W): 480u

Drain Area(AD):

Source Area(AS):

Drain Perimeter(PD):

Source Perimeter(PS):

No. Parallel Devices(M):

MP l=5u w=480u

Monolithic MOSFET - M2

Model Name: MN

Length(L): 5u

Width(W): 124u

Drain Area(AD):

Source Area(AS):

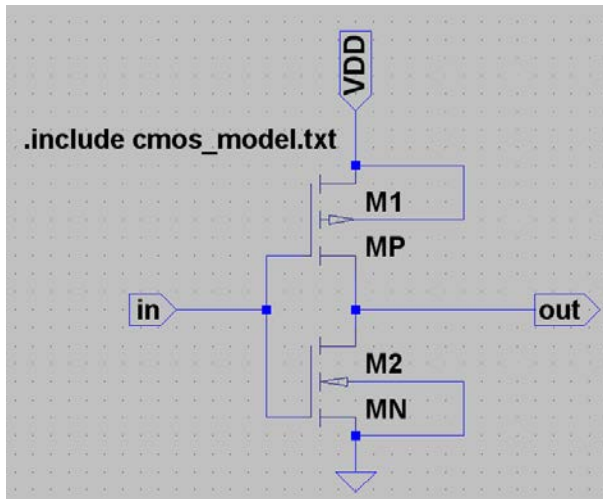
Drain Perimeter(PD):

Source Perimeter(PS):

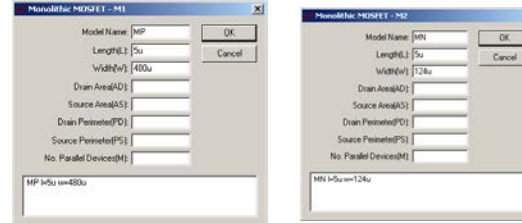
No. Parallel Devices(M):

MN l=5u w=124u

MOS-Old school



Lägg filen `cmos_model.txt` i arbetsmappen. Den innehåller ”skalbara” modeller. Skriv direktivet: `.include cmos_model.txt`



• NMOS

Model Name: **MN**

Length (L): **5u**

Width (W): **124u**

• PMOS

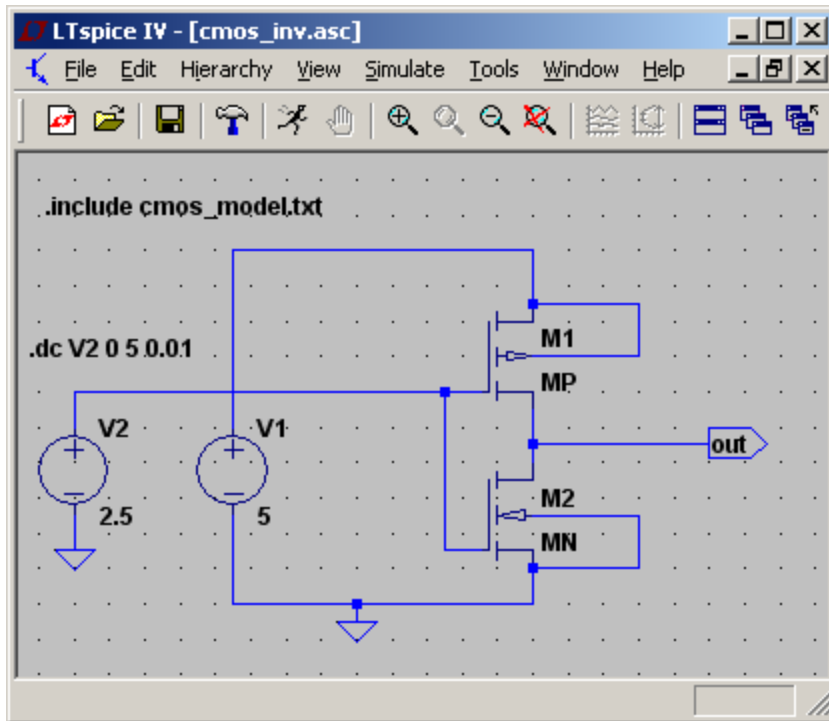
Model Name: **MP**

Length (L): **5u**

Width (W): **480u**

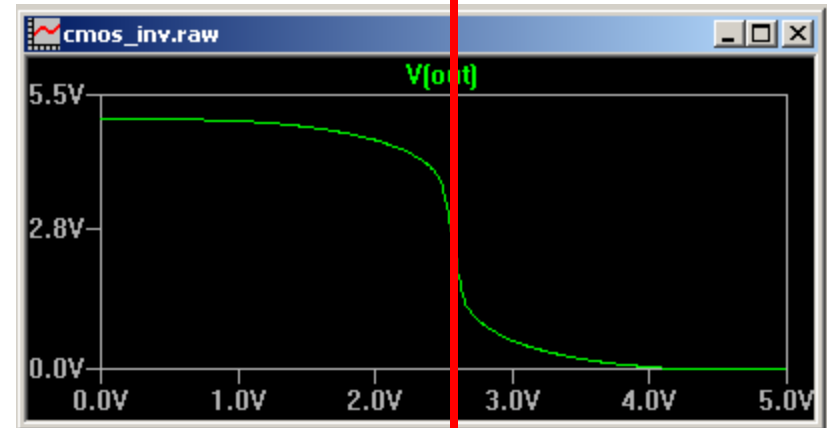
Med dessa val blir de två transistorerna jämnstarka!

CMOS-inverteraren



Simulera med dc-svep:

```
.dc V2 0 5 0.01
```



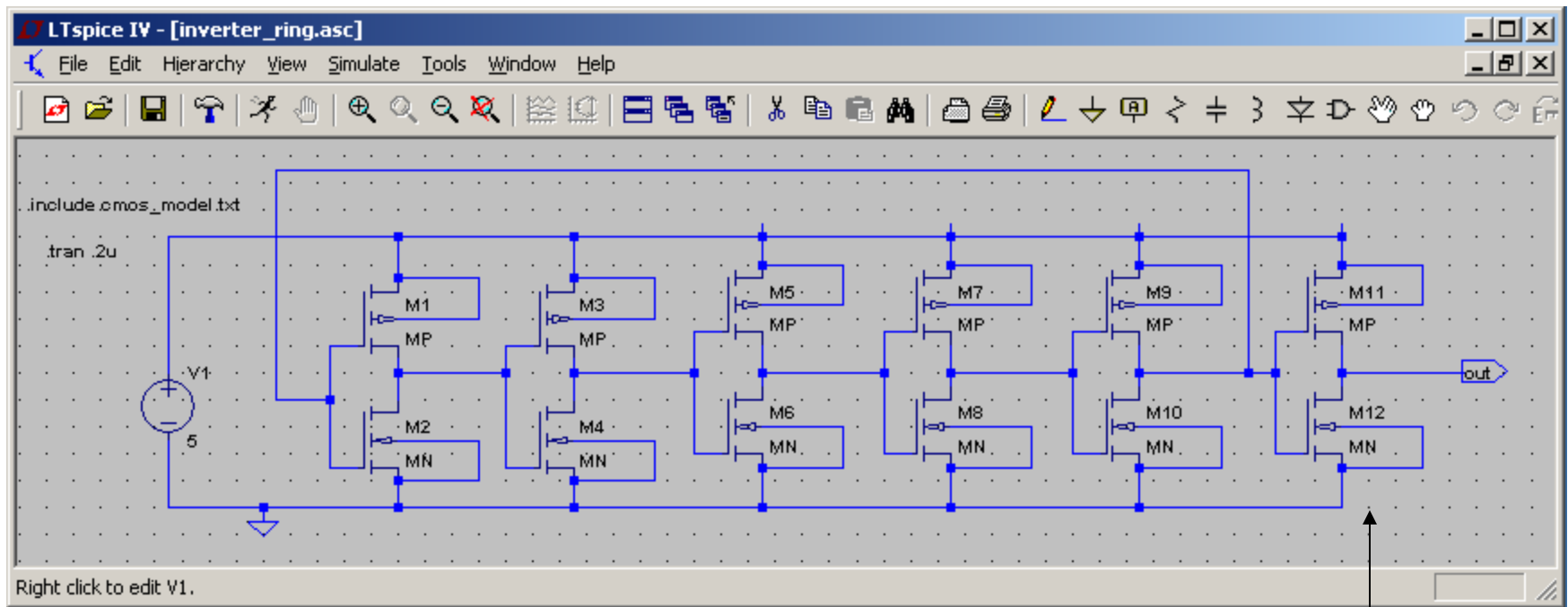
2,5 V

Jämnstarka transistorer ger omslag vid 2,5V.

Ring-oscillator



Kopiera inverteraren 5 ggr! (Vi har ett chip med 6 inverterare)



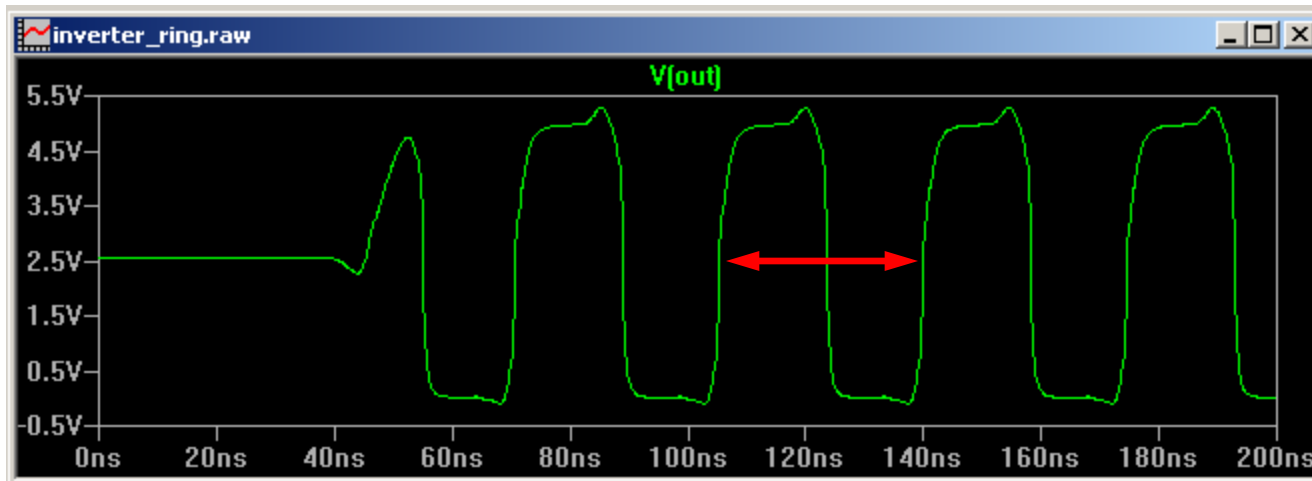
5 inverterare i "ring"

+ Buffer

Ring-oscillator



Simulera med: `.tran .2u`



En inverterares
grundfördröjning: $T_{PD} = \frac{35}{5+5} = 3,5 \text{ ns}$