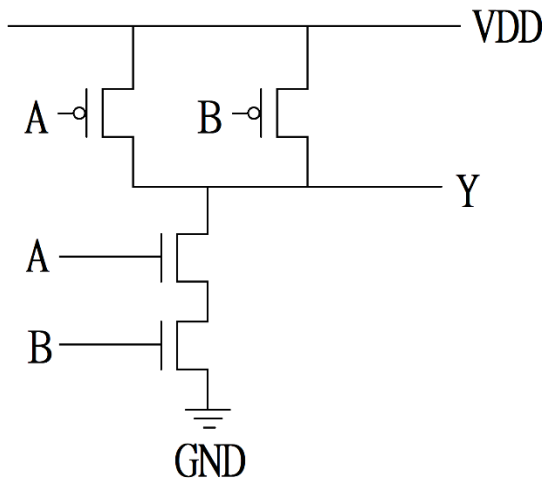
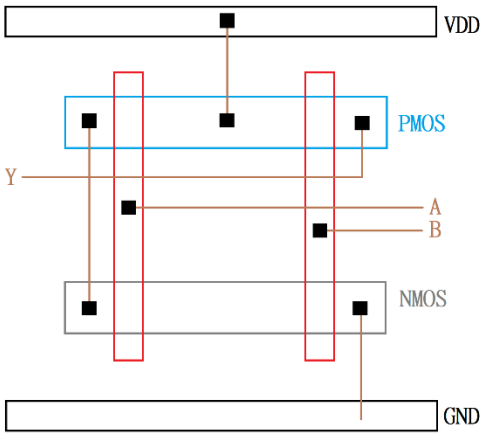
1.(a)

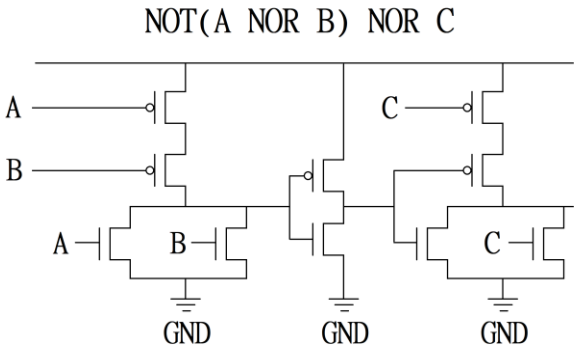
Y = A’+B’ = (AB)’ = A NAND B

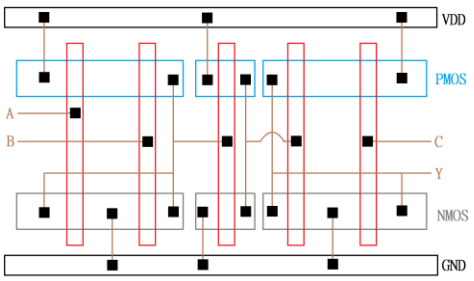




1.(b)

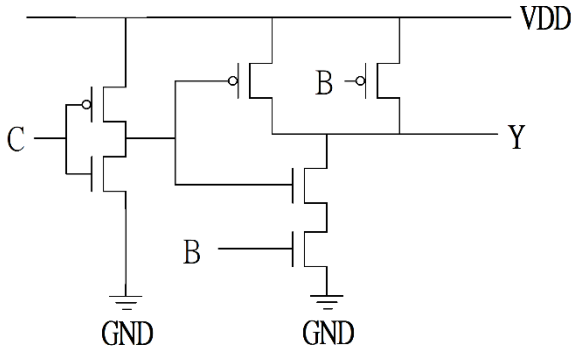
Y = A’B’C’ = (A NOR B)’ NOR C

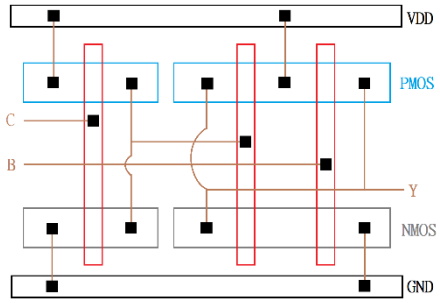




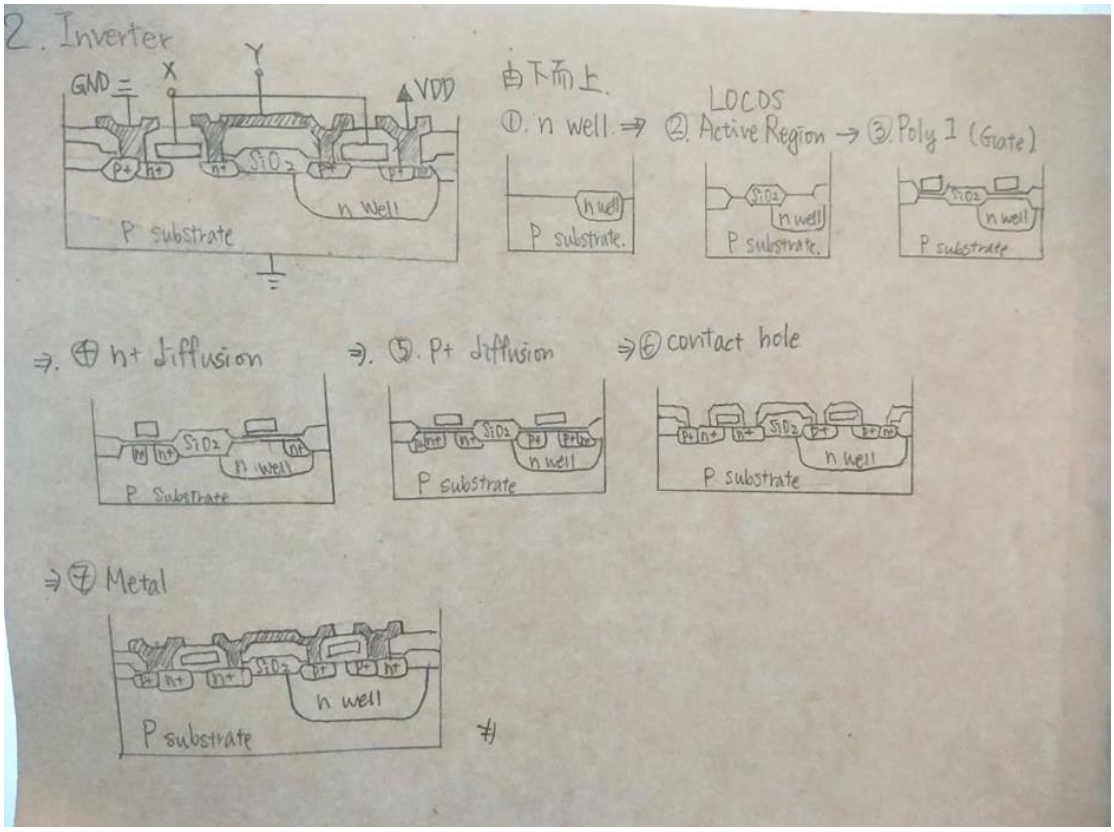
1.(c)

Y = AC+BC+B’ = AC+C+B’ = B’+C = (BC’)’ 對此 function 而言，Input A 不影響 Output Y





2.



2-2

Self-Aligned poly-silicon gate :

先做 Gate，再以 Gate 為 Mask 做 Source, Drain

Prons:

1. Source and Drain automatically aligned precisely
2. Gate is just the size required to cover the channel(Gate is smaller)
3. Since Gate is smaller, the device is faster

2-3

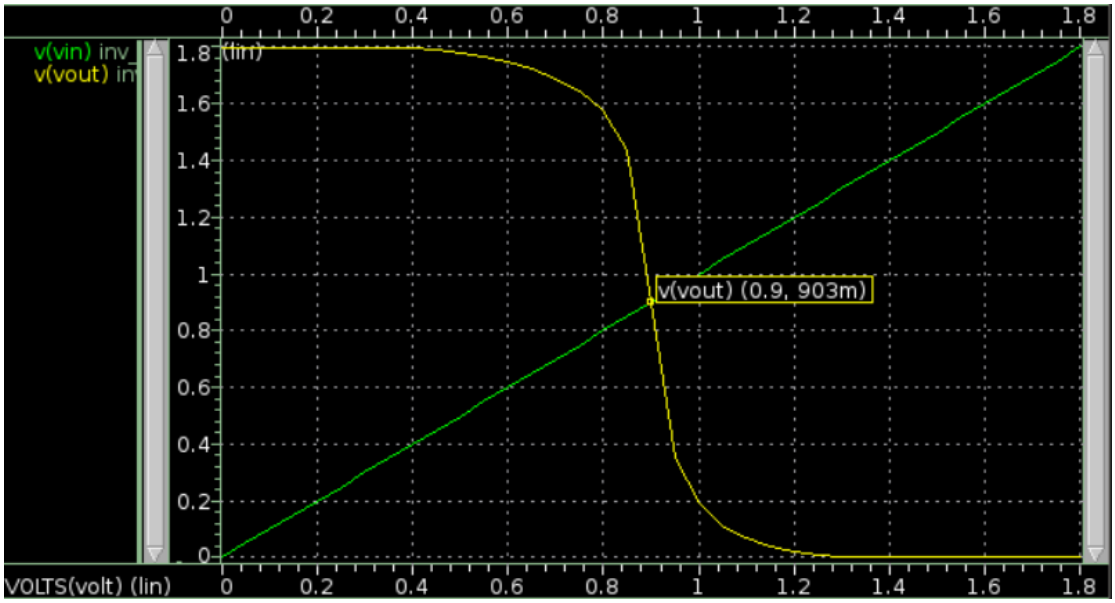
Lightly-Doped Drain(LDD) :

Since channel length is shorter, the electrons from the Source are accelerated in the channel and arrive at the Drain with high velocity and cause **hot carrier effect**.

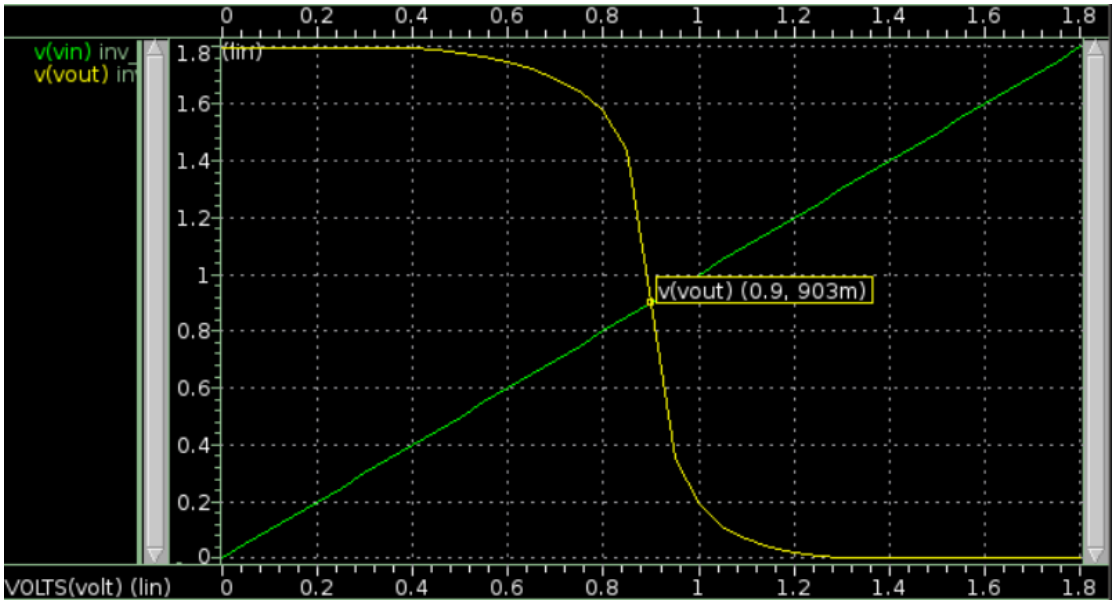
So we lightly doped the drain near the channel compared to the main drain area to reduced hot acrrier effect.

3.(a)

Set NMOS channel length to **1.125u** ,such that Vin = Vout = 0.5xVDD = 0.9

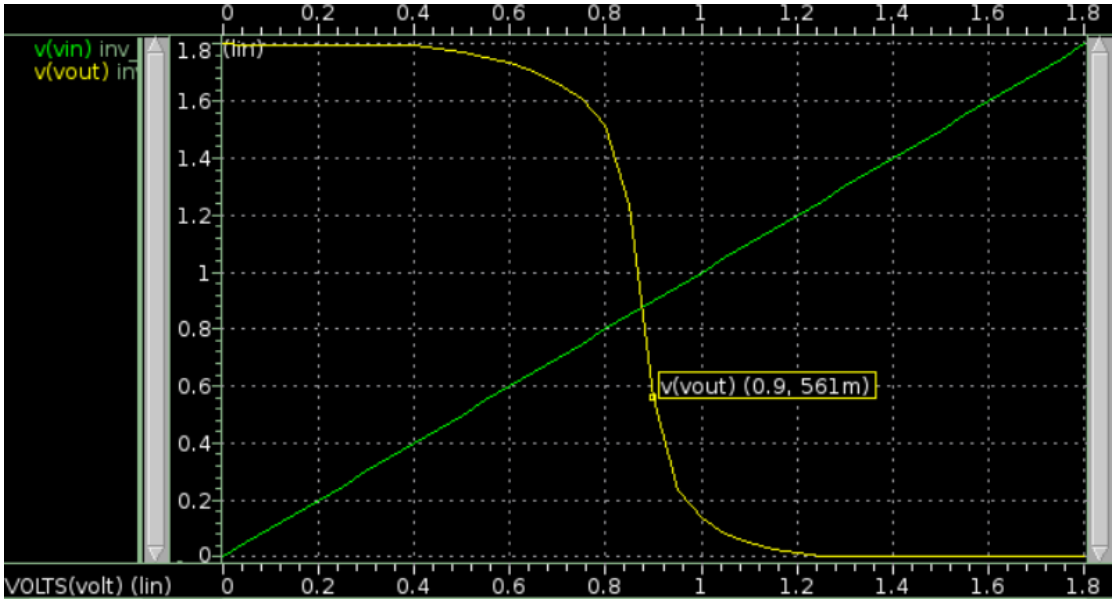


3.(b)-1



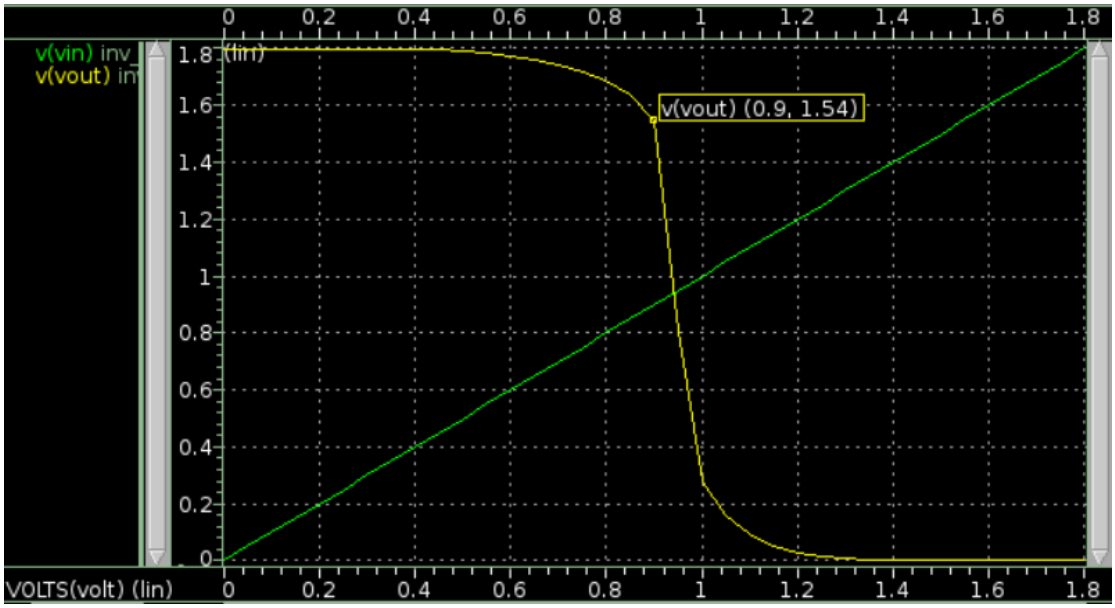
TT / 25°C

3.(b)-2



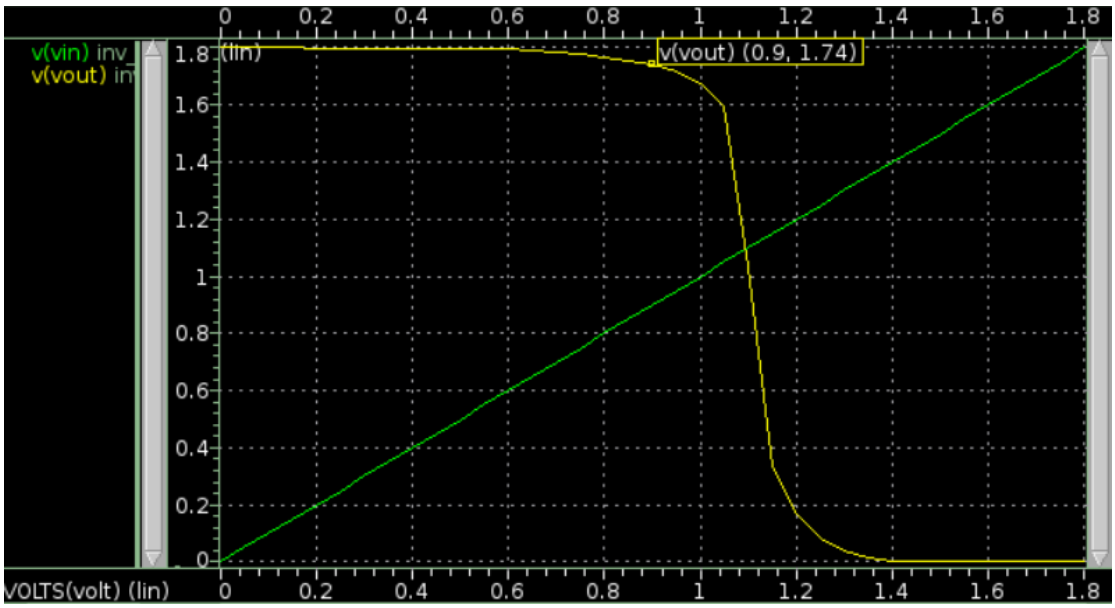
FF / -40°C

3.(b)-2



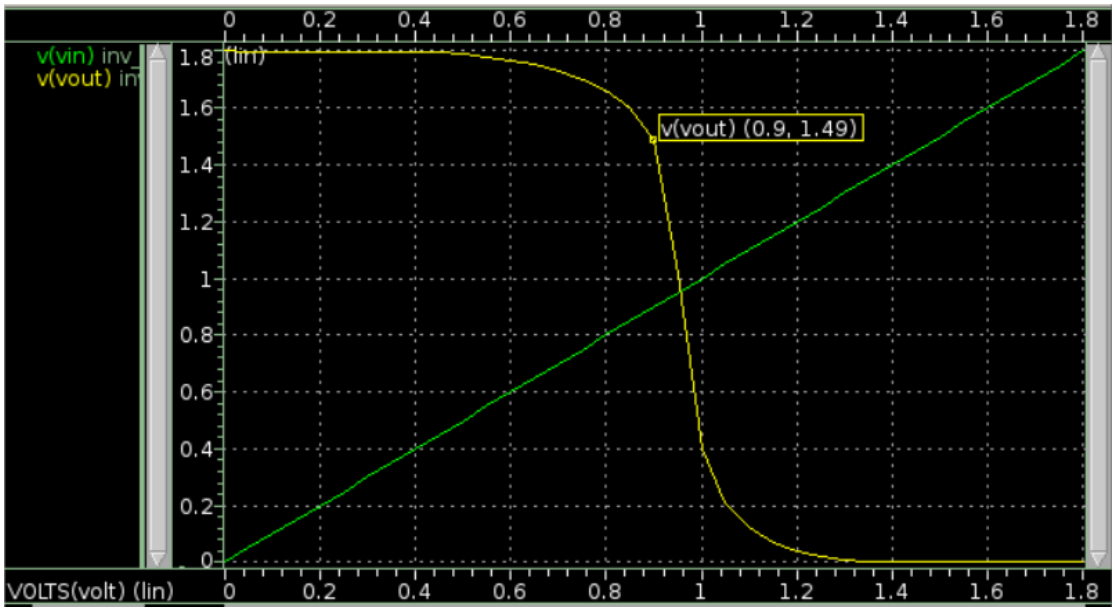
SS / 125°C

3.(b)-4



SF / 25°C

3.(b)-5

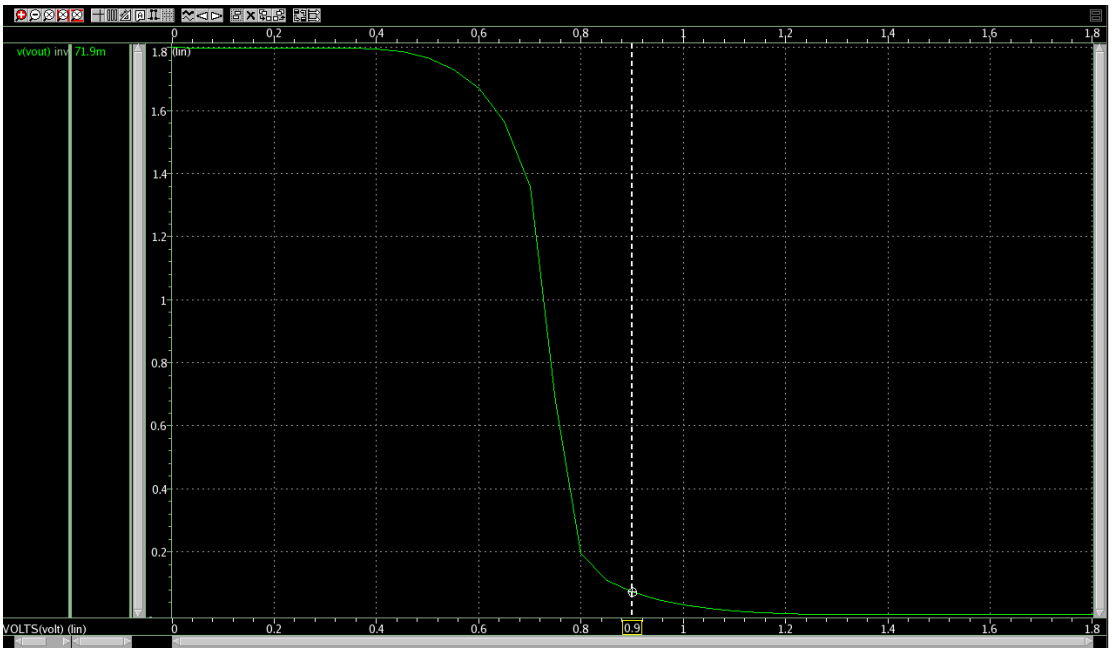


FS / 25°C

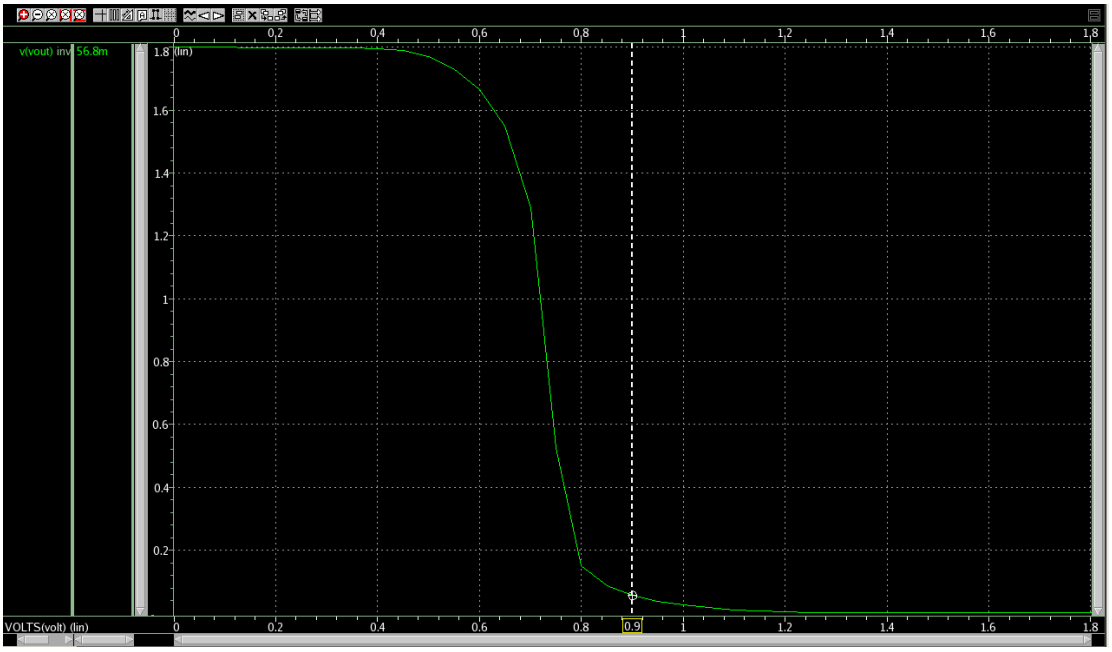
3.(c)

NMOS width 1X 如 3.(b) 所示

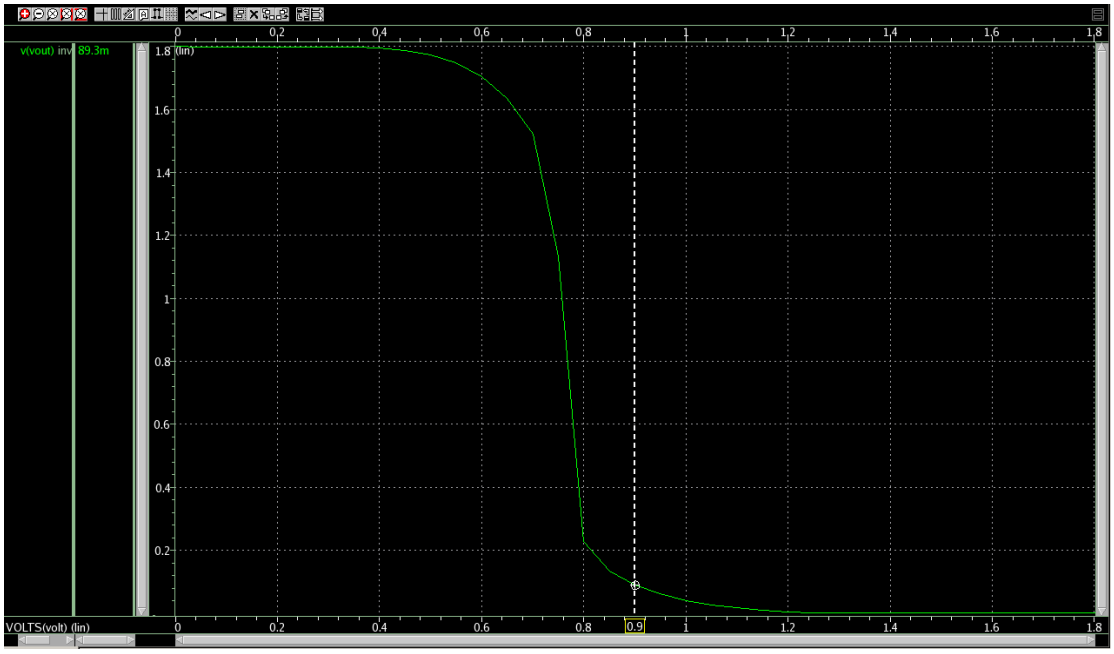
NMOS width 5X 如下所示



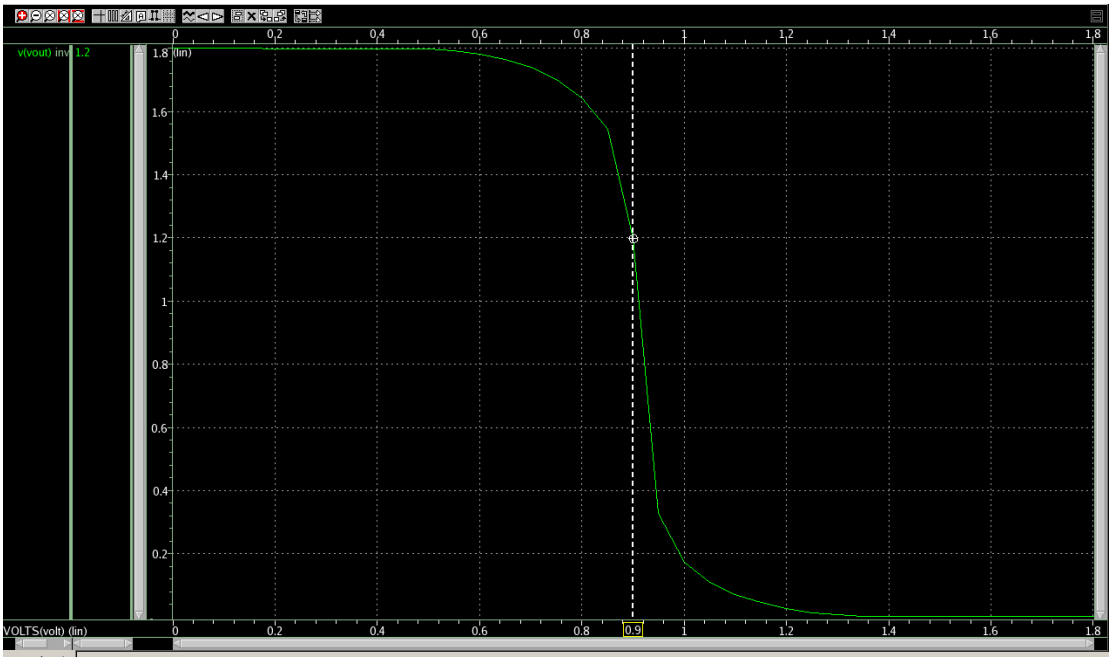
TT / 25°C / 5X



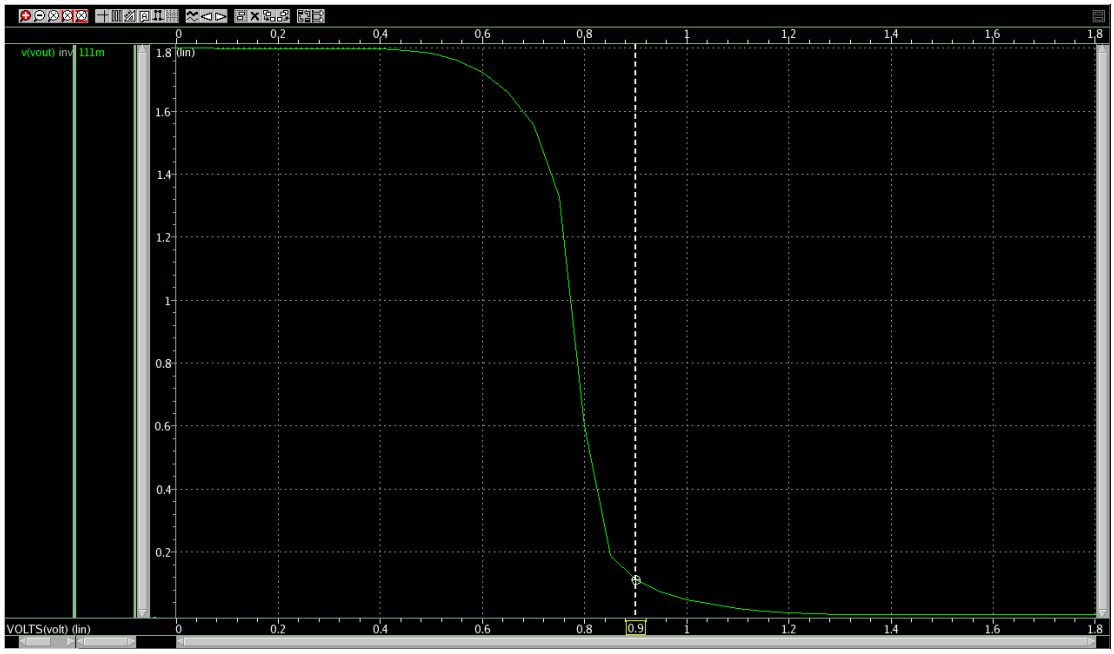
FF / -40°C / 5X



SS / 125°C / 5X



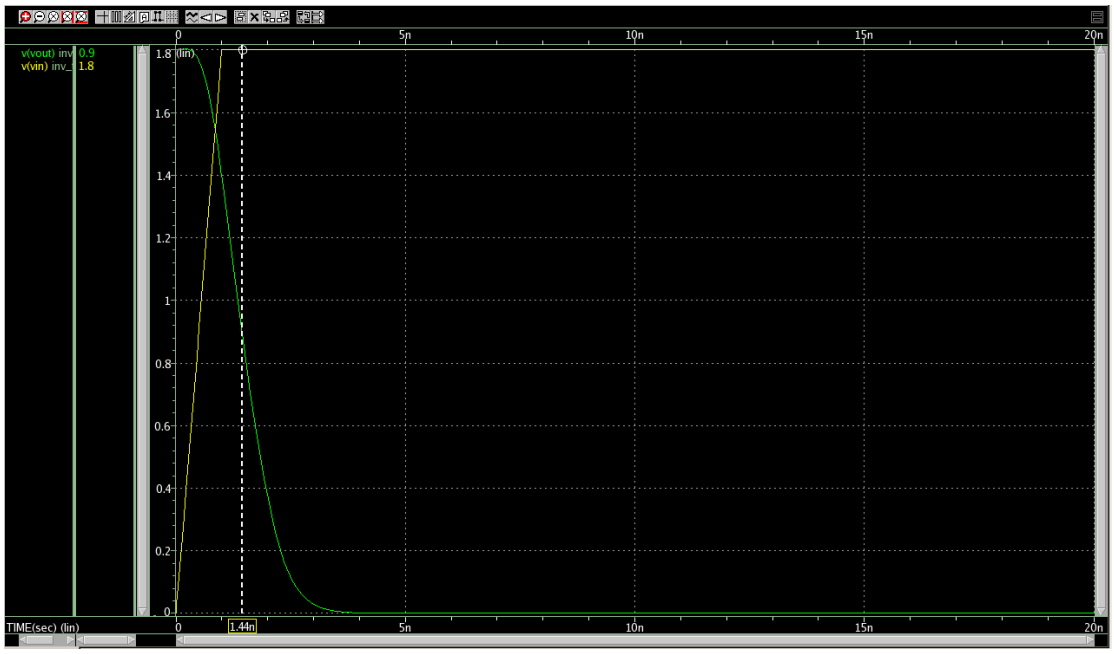
SF / 25°C / 5X



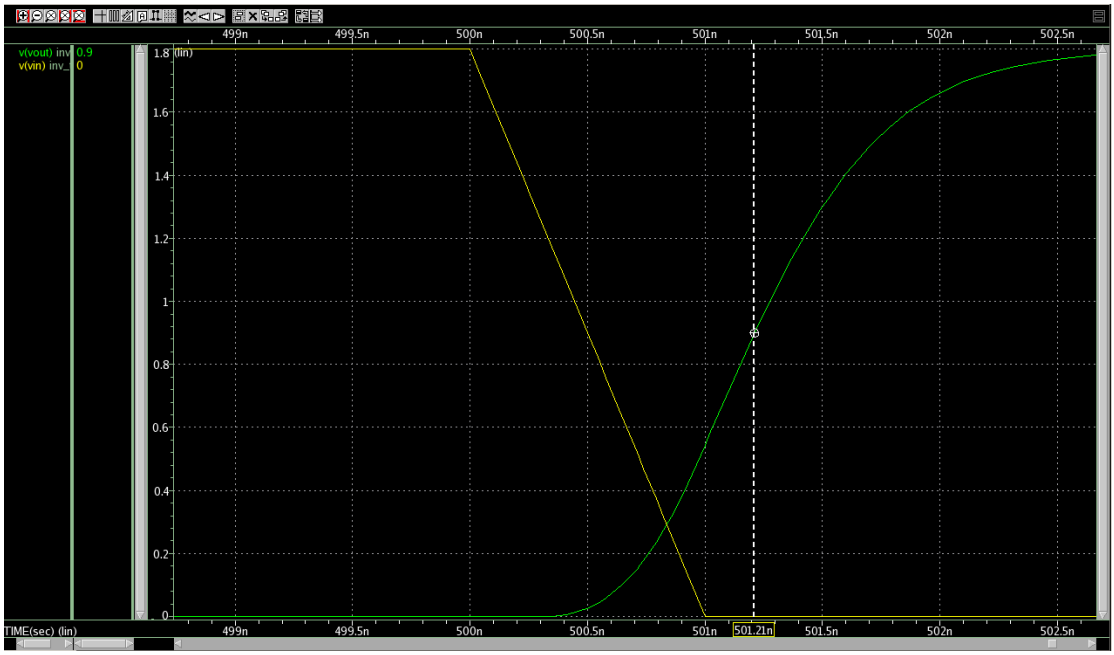
FS / 25°C / 5X

Process	Temperature	NMOS width 1X Vout at Vin=0.5×VDD	NMOS width 5X Vout at Vin=0.5×VDD
TT	25°C	903mV	71.9mV
FF	−40°C	561mV	56.8mV
SS	125°C	1.54V	89.3mV
SF	25°C	1.74V	1.2V
FS	25°C	1.49V	111mV

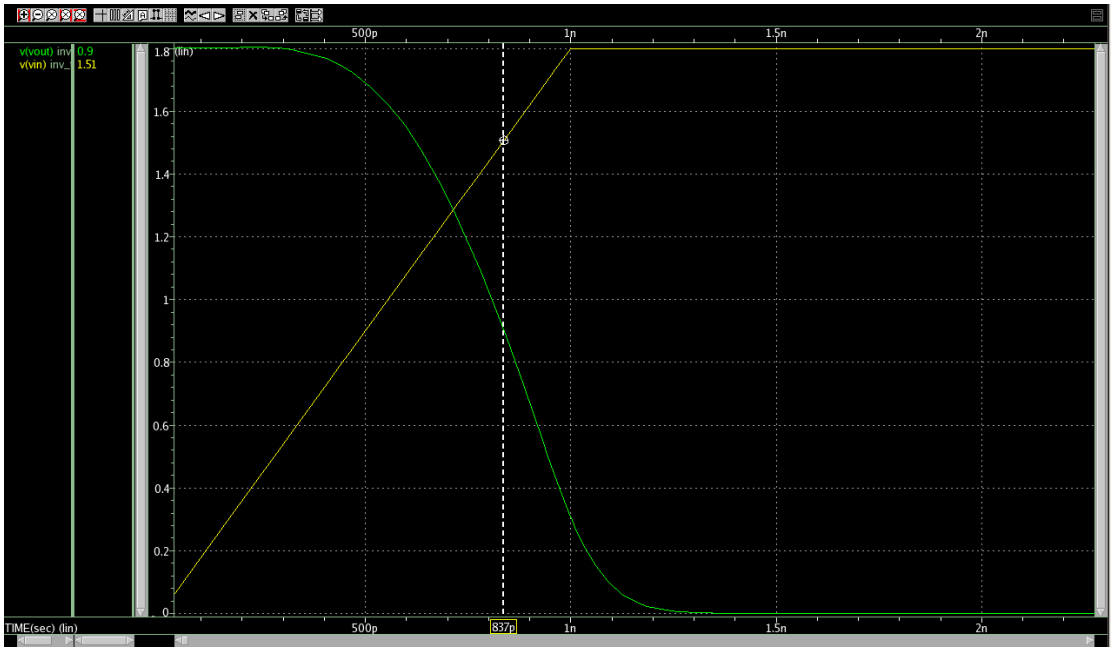
4. TT / 25°C　1X / 5X　Fall/Rise　Delay　如下



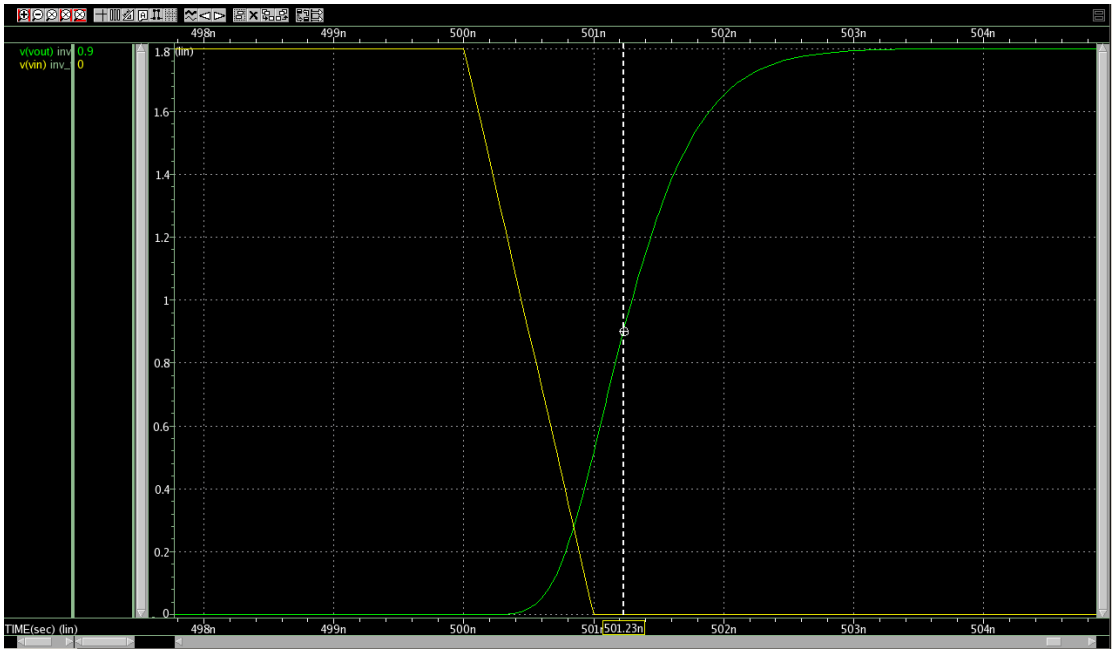
TT / 25°C 1X Fall Delay



TT / 25°C 1X Rise Delay



TT / 25°C 5X Fall Delay



TT / 25°C 5X Rise Delay

其餘如下

Process	Temperature	NMOS width 1X		NMOS width 5X	
		Fall Delay	Rise Delay	Fall Delay	Rise Delay
TT	25°C	0.938ns	0.711ns	0.337ns	0.728ns
FF	–40°C	0.696ns	0.613ns	0.271ns	0.63ns
SS	125°C	2.38ns	1.336ns	0.641ns	1.363ns
SF	25°C	1.988ns	0.607ns	0.566ns	0.621ns
FS	25°C	1.061ns	0.661ns	0.370ns	0.681ns