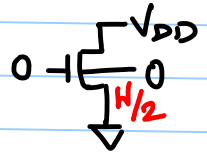
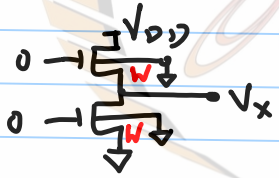
12/09/2019

EE5311

Module - 3 - The Inverter

Stacking Effect





Assumed:

1) $n = 1$
2) Body Effect $\gamma = 0$
3) DIBL $\eta = 0$
4) Large V_{DD} $(V_{DD} > 3\phi_t)$

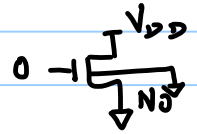
$$I_{LEAK} = I_0 \frac{W}{2} e^{-\frac{V_T}{\phi_t}}$$

$$V_x = \phi_t \ln 2$$

$$I_{BOT} = I_0 \cdot W \, e^{-\frac{V_T}{\phi_t}} \left(1 - e^{-V_x/\phi_t}\right)$$

$$= I_0 \left(\frac{W}{2}\right) e^{-V_T/\phi_t}$$

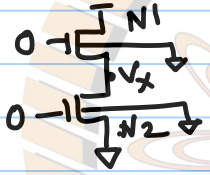
REALITY ($\gamma \neq 0$, $\eta \neq 0$, $n = 1.5$) ($V_{DD} > 3\phi_t$)



$V_{DS} = V_{DD}$

$V_{SB} = 0$

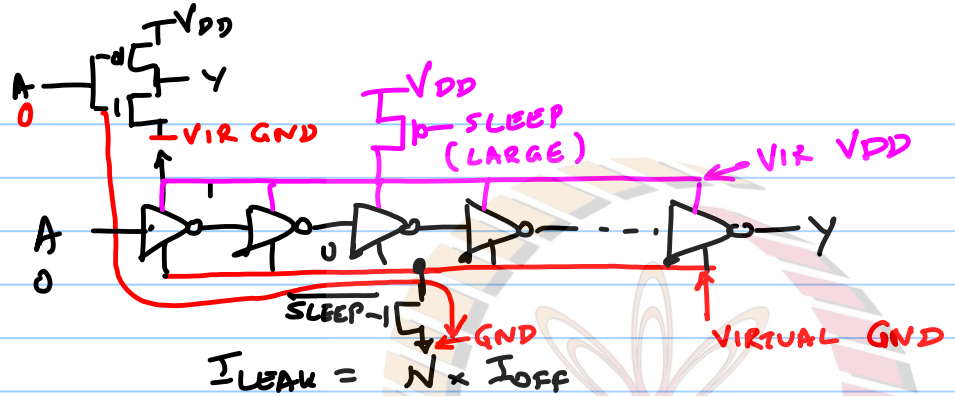
$V_T = V_{TH0} - \eta V_{DD}$



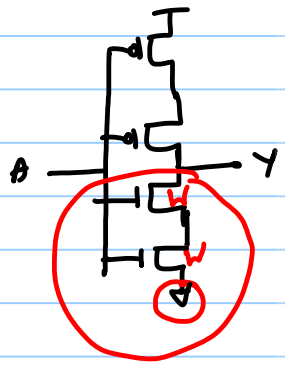
	V_{DS}	V_{SB}	V_{TH}
N1	$(V_{DD} - V_x)$	V_x	$V_{TH0} + \gamma(\sqrt{\lvert V_x + 2\phi_s \rvert} - \sqrt{\lvert 2\phi_s \rvert}) - \eta(V_{DD} - V_x)$
N2	V_x (~ 0)	0	$V_{TH0} - \eta V_x$

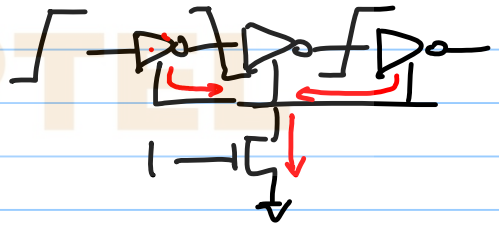
$I_{STACK-2} \ll I_{STACK-1}$

V_{TH} of N1 $\uparrow$ COMPARED TO NO BECAUSE OF (1) DIBL (DOMINATES)
(2) BODY EFFECT



$I_{LEAK} = N \times I_{OFF}$



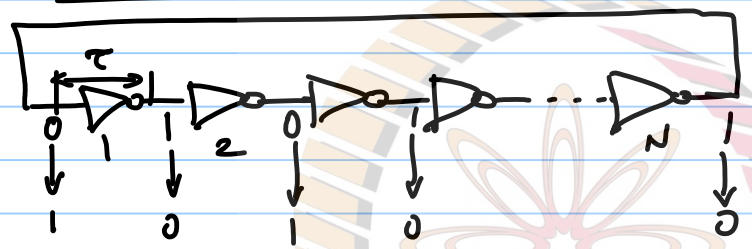


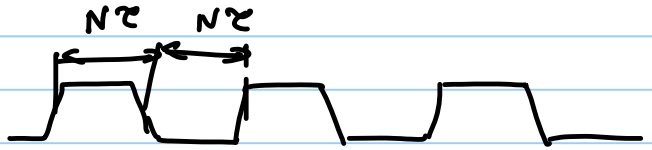
SLEEP = 0 (MISSION MODE)

→ VIR GND ~ GND if W_{SLEEP} LARGE

SLEEP = 1 (SLEEP MODE)

RING OSCILLATOR



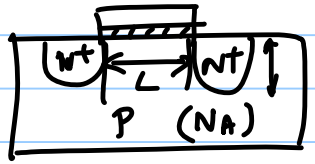


delay = $N\tau$

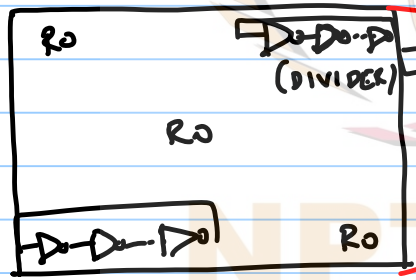
$f = 1/2N\tau$

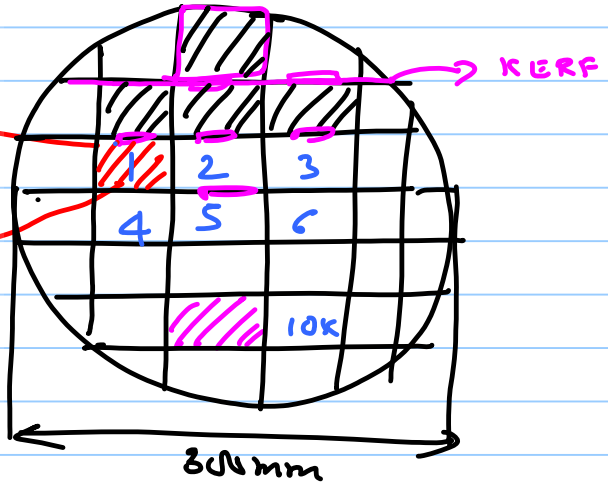
LARGE 'N'

PROCESS VARIATIONS :



$N_A \rightarrow 10^{15}/cm^3$





1) LITHO CHANGES

2) RANDOM DOPANT FLUCTUATION (RDF) → $\sigma_{VT} \propto 1/\sqrt{LW}$