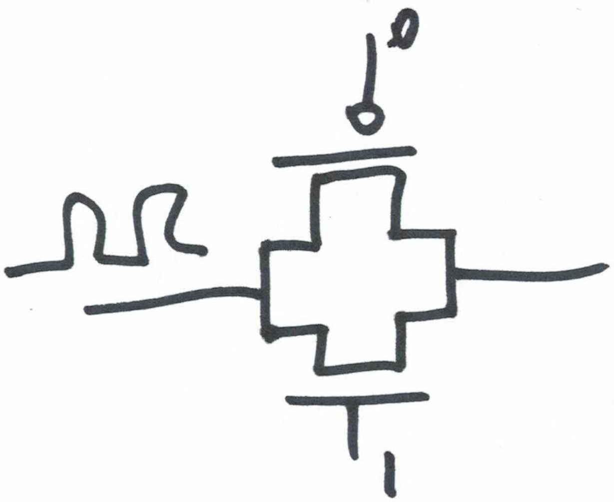
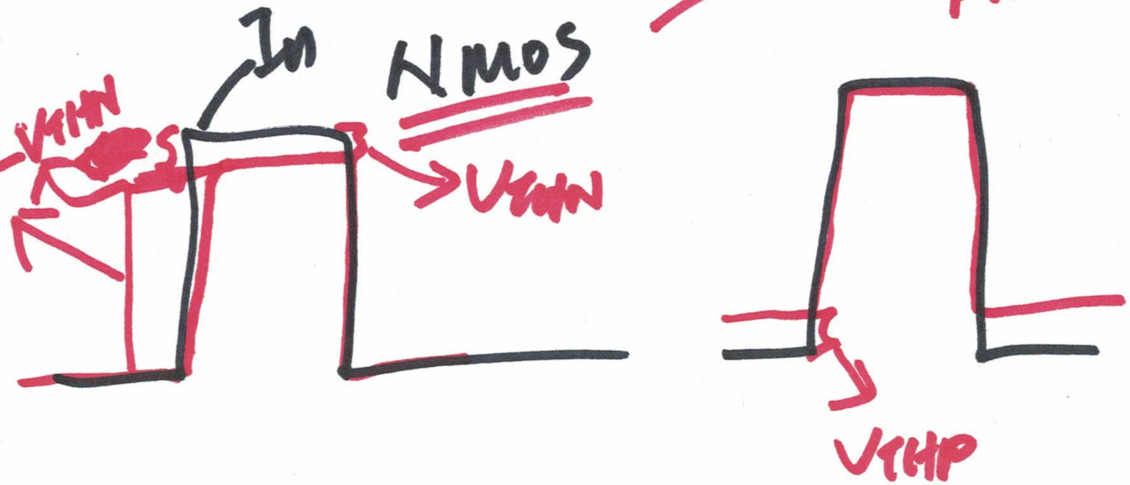
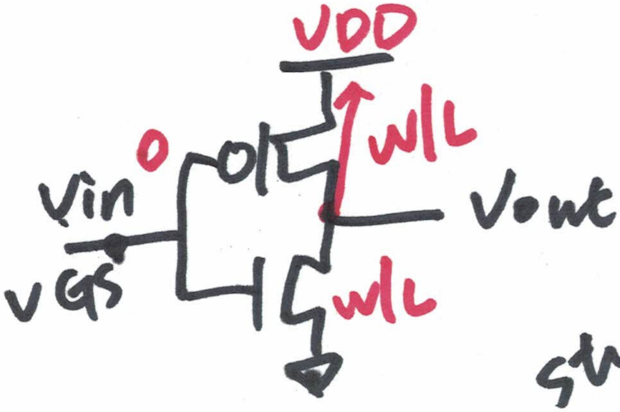
Transmission Gates (TG) / Pass Gates (PG)

PMOS VDD
NMOS GND

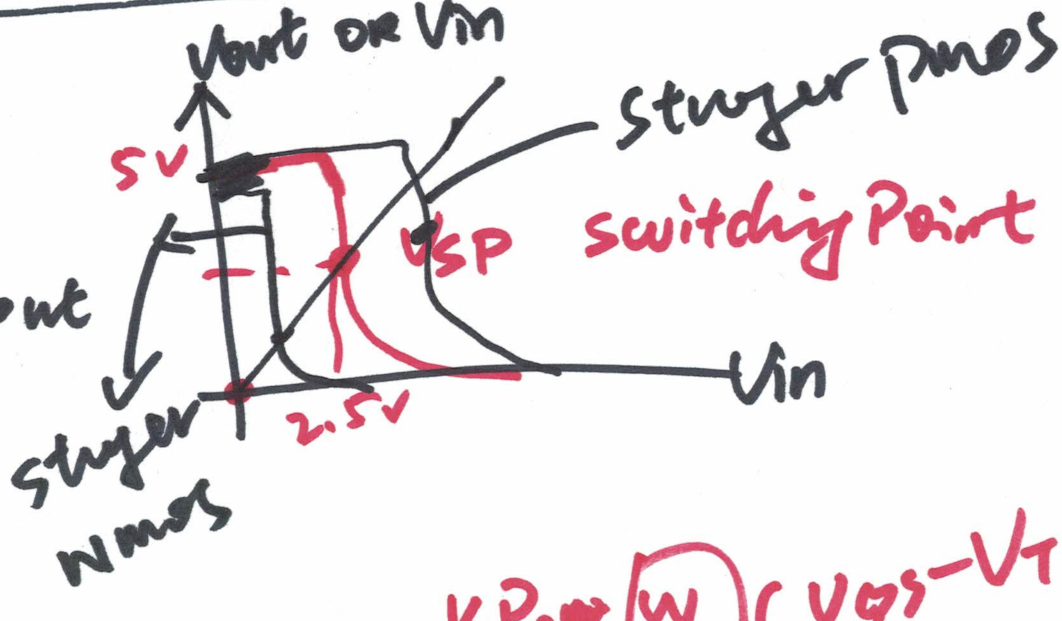




The Inverter Switching Point

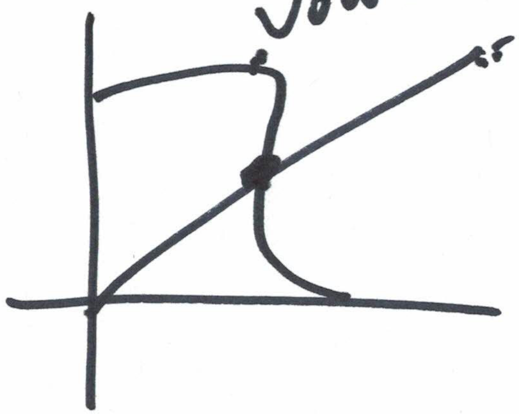


NOT



$$I_{DS} = \frac{KP_n}{2} \frac{W}{L} (V_{GS} - V_{THN})^2$$

Larger W/L, stronger



$V_{in} = V_{out} = V_{sp}$

$$\frac{KP_n}{\cancel{2}}\frac{W}{L} = \beta_n \qquad \frac{KP_p}{\cancel{2}}\frac{W}{L} = \beta_p$$

$$\frac{\beta_n}{2}(V_{GS} - V_{THN})^2 = \frac{\beta_p}{2}(V_{SG} - V_{THP})^2$$

$$\frac{\beta_n}{\cancel{2}}(V_{sp} - V_{THN})^2 = \frac{\beta_p}{\cancel{2}}(V_{DD} - V_{sp} - V_{THP})^2$$

$$\frac{\beta_n}{\beta_p} = \frac{(V_{DD} - V_{sp} - V_{THP})^2}{(V_{sp} - V_{THN})^2}$$

$$\sqrt{\frac{\beta_n}{\beta_p}} = \frac{V_{DD} - V_{sp} - V_{THP}}{V_{sp} - V_{THN}}$$

③

$$\sqrt{\frac{\beta_n}{\beta_p}}\, V_{SP} - \sqrt{\frac{\beta_n}{\beta_p}}\, V_{THN} = V_{DD} - V_{SP} - V_{THP}$$

$$\left(1+\sqrt{\frac{\beta_n}{\beta_p}}\right) V_{SP} = V_{DD} + \sqrt{\frac{\beta_n}{\beta_p}}\, V_{THN} - V_{THP}$$

$$\boxed{V_{SP} = \frac{V_{DD} + \sqrt{\frac{\beta_n}{\beta_p}}\, V_{THN} - V_{THP}}{1+\sqrt{\frac{\beta_n}{\beta_p}}}}$$

$$= 2.5V$$

$$\sqrt{\frac{\beta_n}{\beta_p}} \approx 1 \qquad \beta_n = \beta_p = KP_n \frac{W_n}{L_n} = KP_p \frac{W_p}{L_p}$$

4

$KP_p = 40\ \mu A/V^2$ Because $KP_n = 3KP_p$

$KP_n = 120\ \mu A/V^2$

$$\frac{W_n}{L_n} = 3\frac{W_p}{L_p}$$

15