Lecture 37

Tuesday, October 18, 2016 8:57 AM

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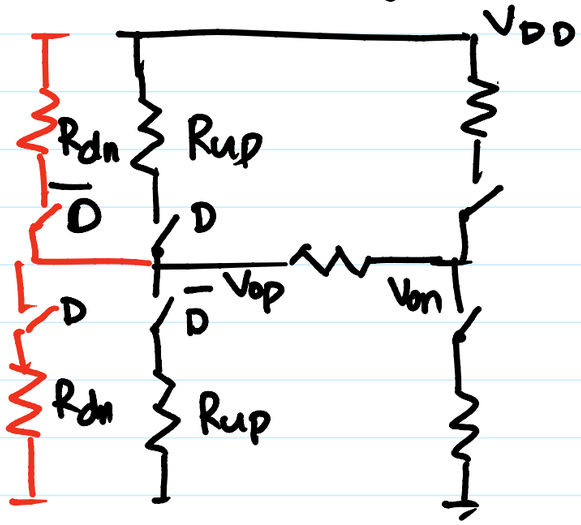
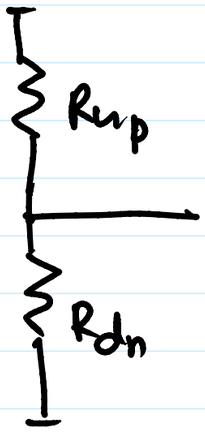
High swing VM o/p driver

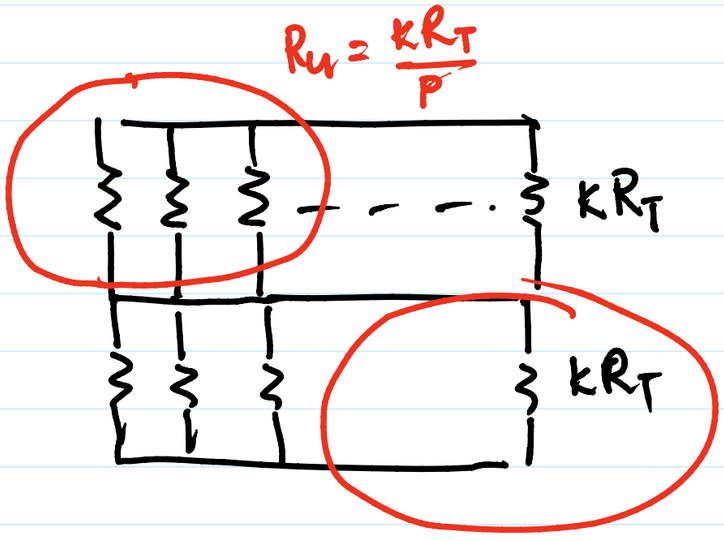




$$V_{out} = V_{op} - V_{on} = \frac{V_{DD}}{2} R_T \left[\frac{1}{R_u} - \frac{1}{R_d}\right]$$

$$\frac{1}{R_u} + \frac{1}{R_d} = \frac{1}{R_T} \quad \text{(Chan. term.)}$$

$$\frac{1}{R_u} - \frac{1}{R_d} = \frac{V_{out}}{V_{dd}/2} \frac{1}{R_T}$$



$$R_d = \frac{kR_T}{(k-P)}$$

$$\frac{1}{R_u} = \frac{1}{2R_T}\left[1 + \frac{V_{out}}{V_{dd}/2}\right]$$

$$\frac{1}{R_d} = \frac{1}{2R_T}\left[1 - \frac{V_{out}}{V_{dd}/2}\right]$$

$$\hookrightarrow G_u = \frac{1}{R_u} = \frac{G_T}{2}\left[1 + \frac{V_{out}}{V_{dd}/2}\right]$$

$$I = \frac{V_{DD} - V_{op}}{R} + \frac{V_{DD} - V_{on}}{R} = \frac{V_{DD} - \left(\frac{V_{DD}}{2} + \frac{V_{out}}{2}\right)}{R} + \frac{\left(V_{DD} - \left(\frac{V_{DD}}{2} - \frac{V_{out}}{2}\right)\right)}{R}$$

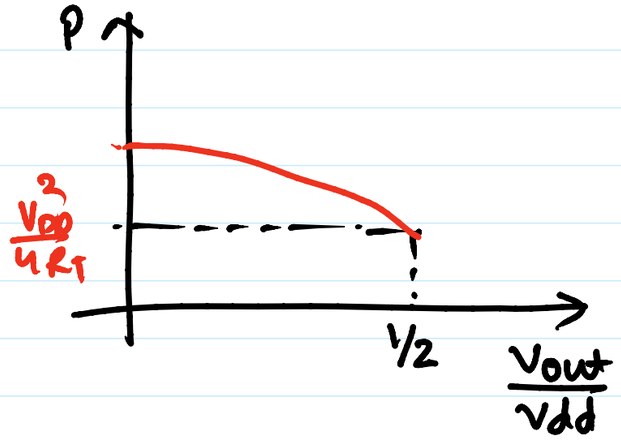
$$I = \frac{V_{DD} - V_{op}}{R_u} + \frac{V_{DD} - V_{on}}{R_d} = \frac{V_{DD} - \left(\frac{V_{DD}}{2} + \frac{V_{out}}{2}\right)}{R_u} + \frac{\left(V_{DD} - \left(\frac{V_{DD}}{2} - \frac{V_{out}}{2}\right)\right)}{R_d}$$

$$= \frac{V_{DD}}{2}\left(\frac{1}{R_u} + \frac{1}{R_d}\right) - \frac{V_{out}}{2}\left(\frac{1}{R_u} - \frac{1}{R_d}\right)$$

$$= \frac{V_{DD}}{2R_T} - \frac{V_{out}}{2} \cdot \frac{V_{out}}{V_{DD}/2 \cdot R_T}$$

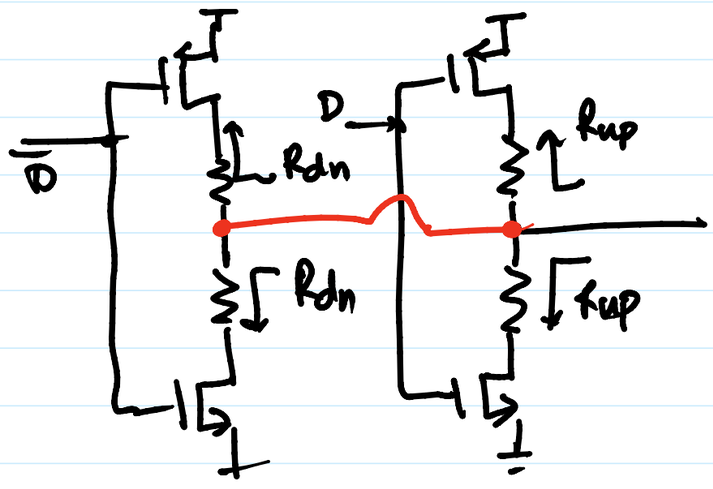
$$= \frac{V_{DD}}{2R_T}\left[1 - 2\left(\frac{V_{out}}{V_{DD}}\right)^2\right]$$

$$P = V_{DD} I = \frac{V_{DD}^2}{2R_T}\left[1 - 2\left(\frac{V_{out}}{V_{DD}}\right)^2\right]$$

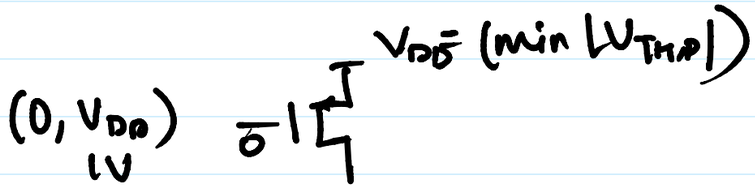


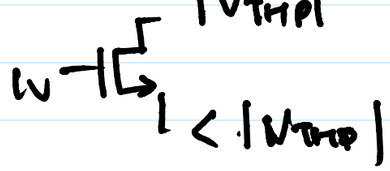
max swing, $V_{out} = \frac{V_{DD}}{2} \Rightarrow P = \frac{V_{DD}^2}{4R_T}$

min swing $V_{out} = 0 \Rightarrow P = \frac{V_{DD}^2}{2R_T}$



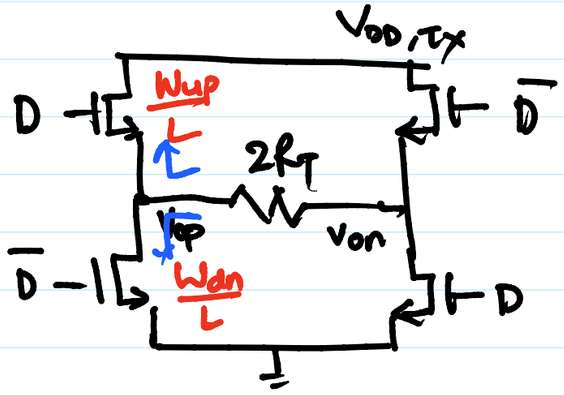
Drawback: Resistive divider more power consumption

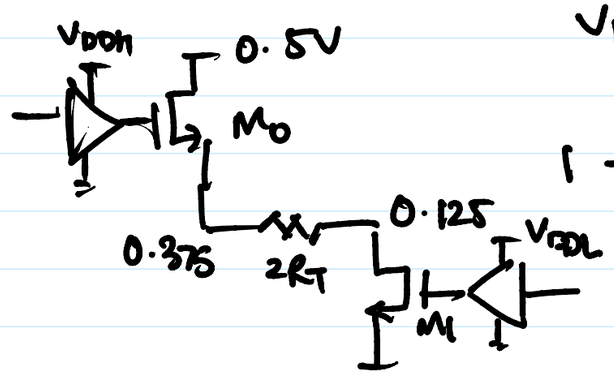




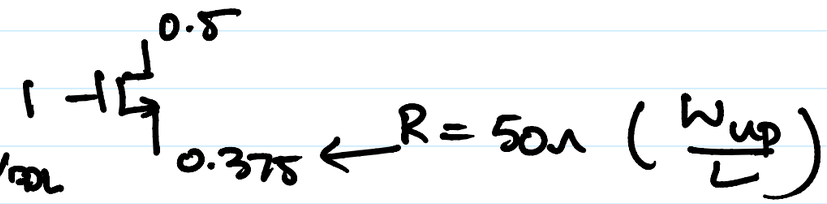
$1 - |V_{THP}| > V_{THN}$

Low swing o/p driver (N over-N)





$V_{DS} = 0.125$, $V_D = 0.5V$, $V_S = 0.375V$

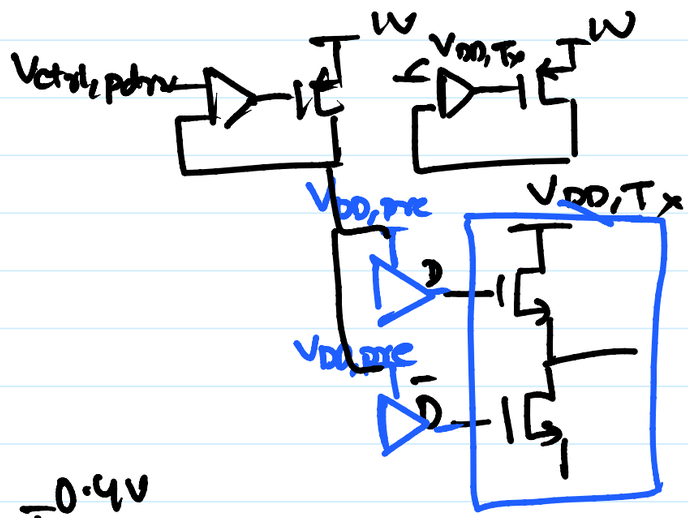


0.5 → 0.4 V

$R_T = 50\Omega$, ~~V_{DDH}~~, ~~$\frac{W_{up}}{L}$~~

* Different control voltage for M_0, M_1 s.t. $R_{up} = R_{dn} = 50\Omega$

* Same control voltage, $M_0 = \frac{W_{up}}{L}$ $M_1 = \frac{W_{dn}}{L}$ $W_{up} > W_{dn}$

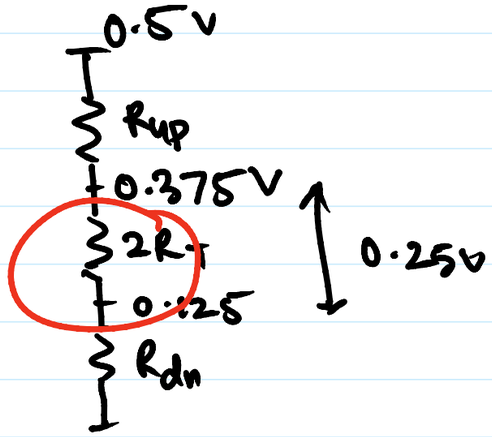


Output swing = $\frac{V_{DD,Tx}}{2}$

Vary o/p swing

T 0.5V

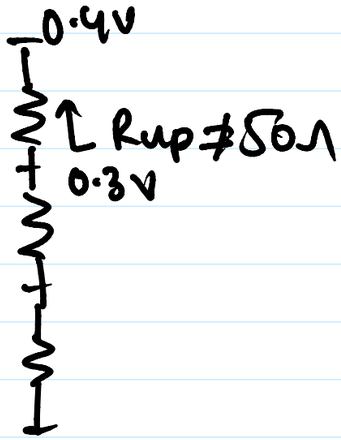
T 0.4V



$V_{ctrl} = 1V$

$V_{gs} = 0.625V$

$I = 2.5mA$

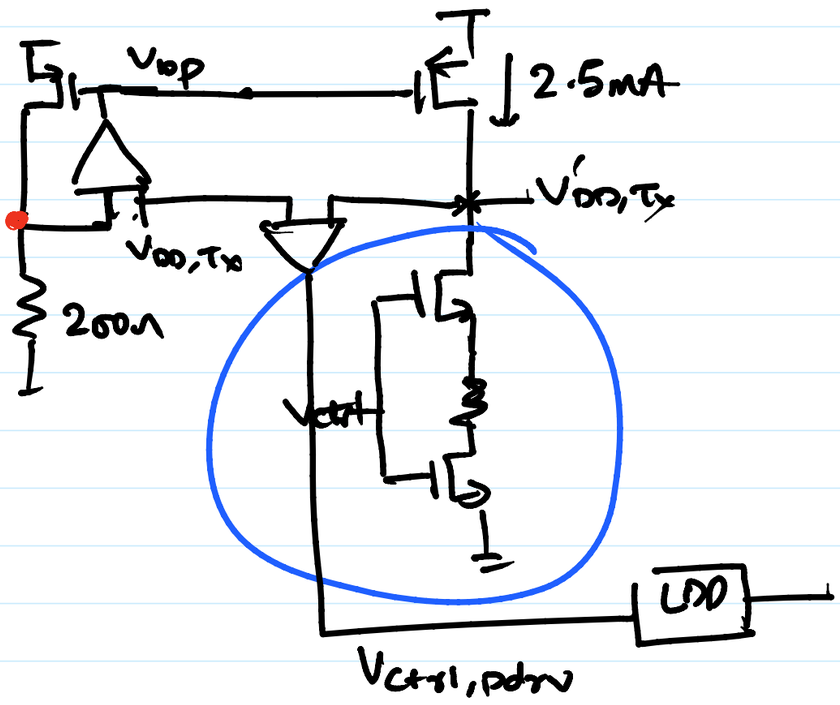


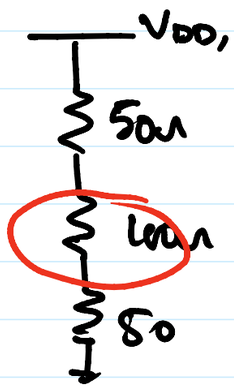
$I = 2mA$

$V_{gs} = 0.625$

$V_g = 0.925$

if $R_{up} = 50\Omega \Rightarrow V_{out} = \pm 0.2V$





o/p driver.

$I = \frac{V_{DD,Tx}}{200}$

Power (±0.25V from high-swing o/p driver) $= \frac{V_{DD}^2}{2R_T}\left[1 - 2\left(\frac{V_{out}}{V_{DD}}\right)^2\right]$

$= \frac{V_{DD}^2}{} \left[1 - 2 \times \frac{1}{7} = \frac{7}{} \quad \frac{V_{DD}^2}{} = \frac{7}{}\right.$

$$= \frac{V_{DD}^2}{2R_T}\left[1 - 2 \times \frac{1}{16}\right] = \frac{7}{8} \quad \frac{V_{DD}^2}{2R_T} = \frac{7}{16R_T}$$

Power (± 0.25V from N-over-N) $= \frac{0.5}{4R_T} \times V_{DD} \times \frac{V_{DD}}{4R_T} = \frac{V_{DD}}{8R_T} = \frac{1}{8R_T} \times \frac{2}{16R_T}$