10.1 $C = 50fF$. $C_D = 400fF$. $V(C) = V(\frac{C}{2}) = V_T = 0V$ (区域1)

在区域1时, $I = W \cdot v_{sat} \cdot C_{ox} \cdot \frac{(V_{GS} - V_{T,n})^2}{(V_{GS} - V_{T,n}) + E_c L_n} \Rightarrow$

$$V_{GS} - V_{T,n} = V_{DD} - V_D - V_{T,n} = 0$$

$$V_D = V_{DD} - V_{T,n} = 3V$$

区域1有电荷共享.

预充电阻断: $V_D = V_{DD} - V_{T,n} = 3V$

(1) 如果C板上的电压是0, 则:

$$C_D V_{D0} + C(-V_{DD}) + \frac{C}{2}(-V_{DD}) = C_D(V_D - 0) + C(V_D - V_{DD}) + \frac{C}{2}(V_D - V_{DD})$$

$$V_D = 2.526V$$

当DS变低, CS变高, 右侧电压仍为3V

左半电压会置0. 最终V_D的稳态电压是0V

(2) 如果C上电压为V_{DD}, 则:

$$C_D(V_{D0} - 0) + C(V_{DD} - V_{DD}) + \frac{C}{2}(-V_{DD}) = C_D(V_D - 0) + C(V_D - V_{DD}) + \frac{C}{2}(V_D - V_{DD})$$

$$V_D = 3.053V$$

当DS变低, CS变高. 左侧V_D高、下置0. V_D稳态电压为3V

10.2 $V_{T0}=1.0V$. $\gamma = 0.3V^{\frac{1}{2}}$ $|2\phi_F| = 0.6V$

(a) 写 1 后，位线 $V_{D17}=5V$. C_S的最大电压

工作于饱和区.

$$I_S = W\, V_{sat}\, C_{ox} \cdot \frac{(V_G - V_S - V_{T,n})^2}{(V_G - V_S - V_{T,n}) + E_c L_n} = 0$$

$$V_T = V_{T0} + \gamma\left(\sqrt{|2\phi_F| + V_{SB}} - \sqrt{|2\phi_F|}\right)$$

不考虑衬偏效应 $\begin{cases} V_{t0} = 1V. \\ V_S = 4V \end{cases}$ 考虑衬偏效应 $\begin{cases} V_{t0} = 1.384V \\ V_S = 3.616V \end{cases}$

(b). 读1时，发生电荷共享.

$$C_S V_S + C_{BL} V_{BL} = (C_S + C_{BL}) V$$

$$V = \frac{C_S V_S + C_{BL} V_{BL}}{C_S + C_{BL}} = 2.65\,V$$

10.3

行向延迟

行方向的总电阻: $R_{row} = 25 \times 5 \times 64 = 8k\Omega$

行方向的电容:

线电容: $C_{line} = C_{poly} \cdot (10\times10^{-4}\times64 - 4\times10^{-4}\times64)$

$= 84.48fF$

栅电容: $C_{g1} = C_{gd} + C_{gs} = C_{ox}WL_D + (\frac{2}{3}C_{ox}WL + C_{ox}WL_D)$

$= 2.333\cdots fF$

$C_{g2} = C_{gd} + C_{gs} = (\frac{1}{2}C_{ox}WL + C_{ox}WL_D) + (\frac{1}{2}C_{ox}WL + C_{ox}WL_D)$

$= C_{ox}WL + 2C_{ox}WL_D$

$= 2.8fF$

$t_{row} = 0.38RC = 0.38R(C_{poly} + 30C_{g1} + 34C_{g2})$

$= 0.759ns$

位线延迟

线电容: $C_{metal} \times 12 \times 10^{-4} \times 64 = 0.1536pF$

$C_{db} = A \cdot C_{j0} \cdot K_{eq} + P C_{jsw} K_{eq}$

$= 5.1fF$

$C_{gd} = C_{ox}WL_D = 350 \times 10^{-6} \times 4 \times 0.5 \times 10^{-12} = 0.7fF$

总电容为: $C_L = C_M + 20 \times (C_{db} + C_{gd}) = 0.2696pF$

1 $(V_{in} = 5V, V_{out} = 5V) = \frac{1}{2}k_n' \frac{W}{L_{eff}}(V_{GS} - V_T)^2 = 0.64mA$

2 $(V_{in} = 5V, V_{out} = 2.5V) = \frac{1}{2}k_n' \frac{W}{L_{eff}}(2(V_{GS} - V_T)V_{DS} - V_{DS}^2) = 0.55mA$

$I_{avg} = \frac{1}{2} \times (0.55 + 0.64) = 0.595\,mA$

$t'_{pHL} = \frac{C_L \Delta V}{I_{avg}} = 1.11328\,ns$

$t_{pHL} = t'_{pHL} + t_{row} = 1.8918\,ns$

10.4

M_3: $V_{GS} = 4.5V$ $V_{DS} = 0.7 - 0.5 = 0.2V$

$V_T = V_{T,n} + \gamma\left(\sqrt{0.6+0.5} - \sqrt{0.6}\right) = 0.81V$

$I_{D,M5} = I_{D,M3}$

M_5, M_6:

$\frac{k_{p,5}}{2}(0 - V_{DD} - V_{T,p})^2 = \frac{k_{n,3}}{2}(2(4.5 - 0.8) \times 0.2 - 0.2^2)$

$\left(\frac{W}{L}\right)_{5,6} = 0.078$

10.6 (a) $R_{WL} = 2^6 \times 8 \times 390\,\Omega = 199680\,\Omega$

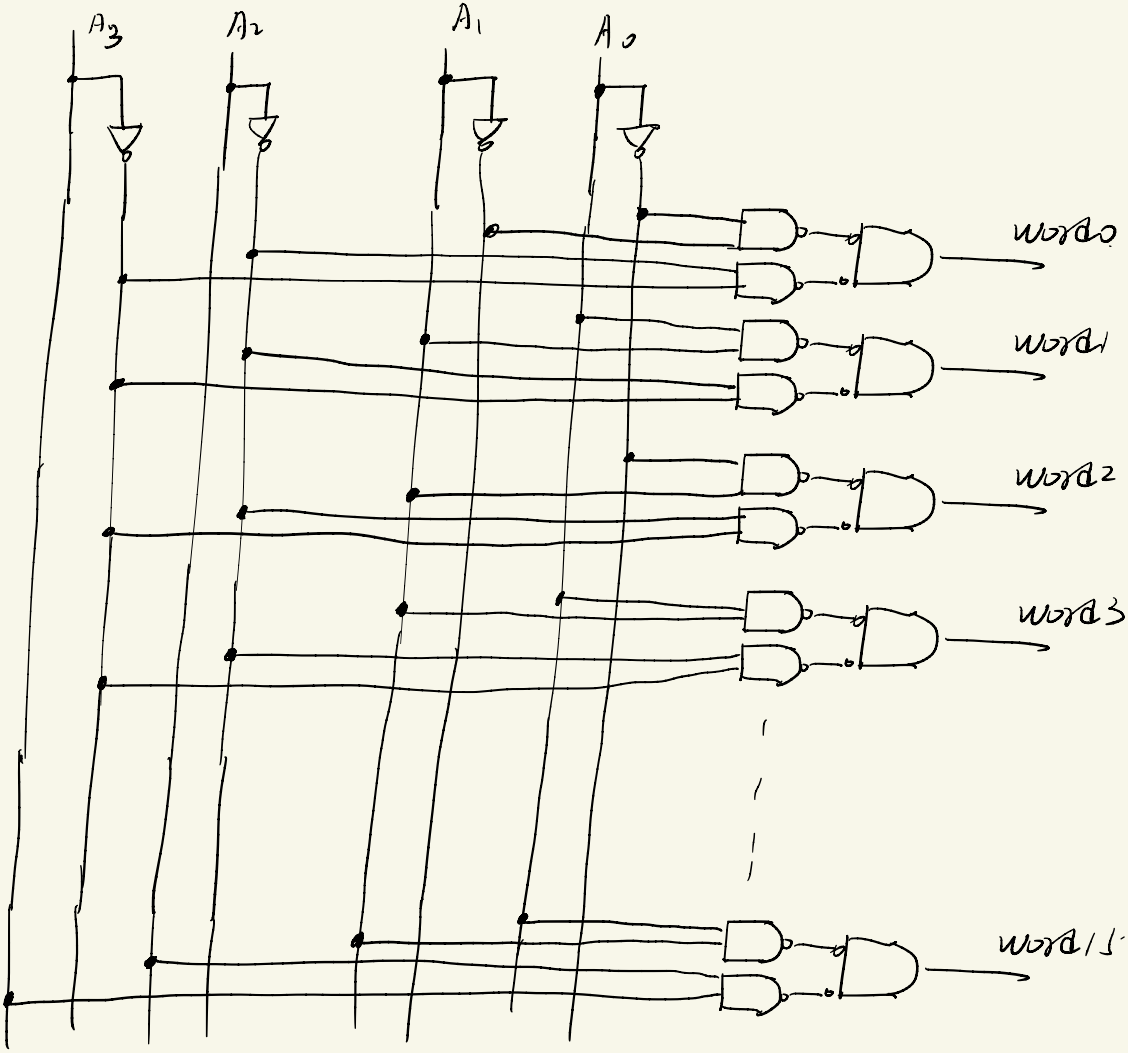
(b) $C_{WL} = 2^6 \times 8 \times 22\,fF = 11264\,fF$

(c) $C_{BL} = 2^7 \times 6\,fF = 768\,fF$

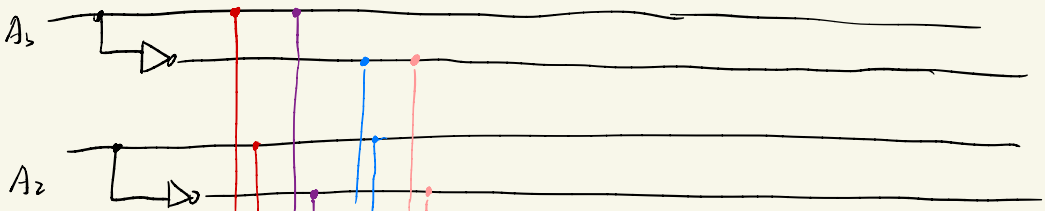
(d) $t_{row} = 0.69 \times 390\,\Omega \times 22\,fF \times \frac{(2^6 \times 8)(2^6 \times 8 + 1)}{2} = 0.7725\,ns$

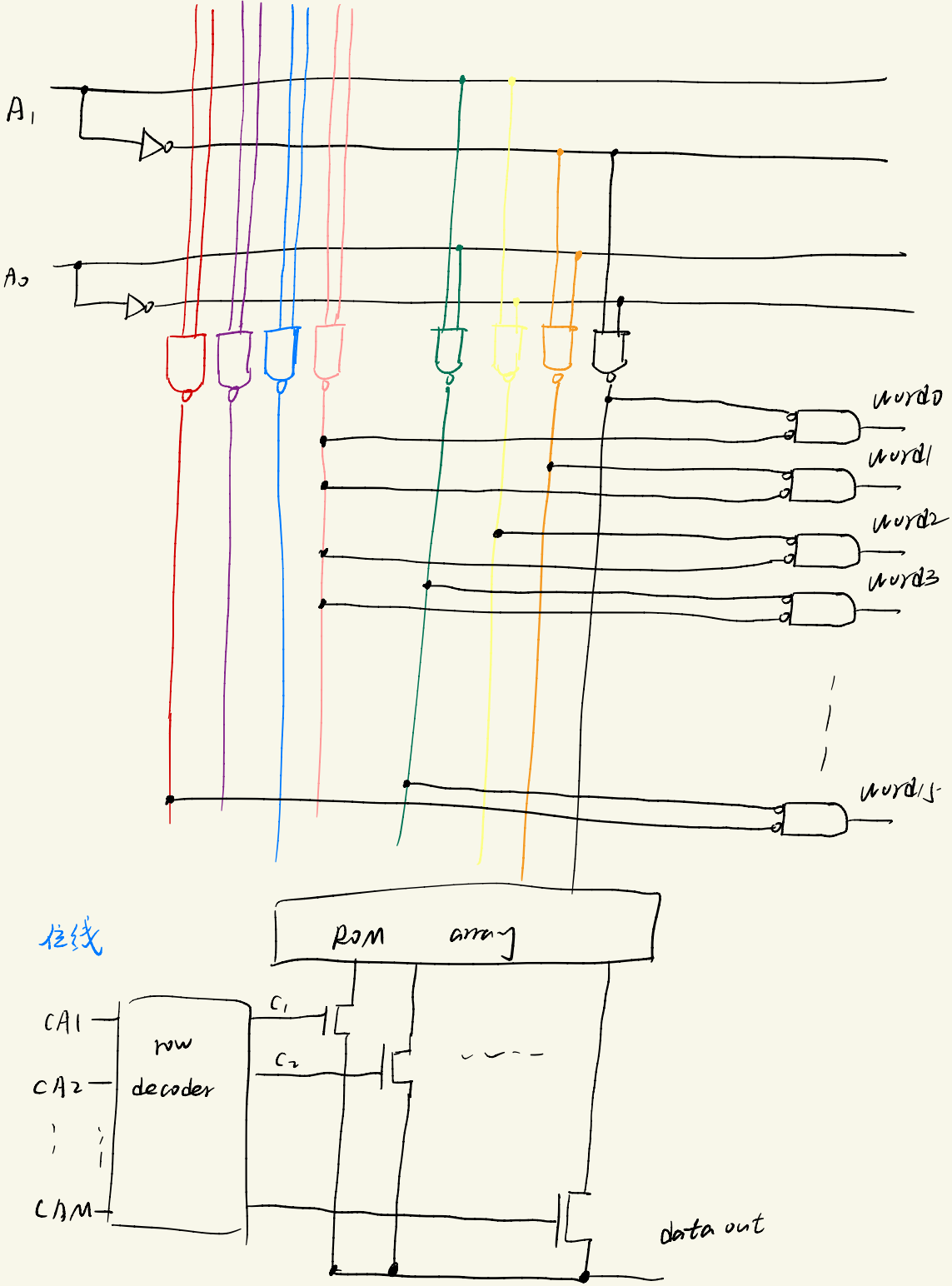
字线

(e). 4位译码器(直接译码)



4位颜译码




A1
A0
word0
word1
word2
word3
word15
位线
ROM array
CA1
CA2
CAM
row decoder
C1
C2
data out