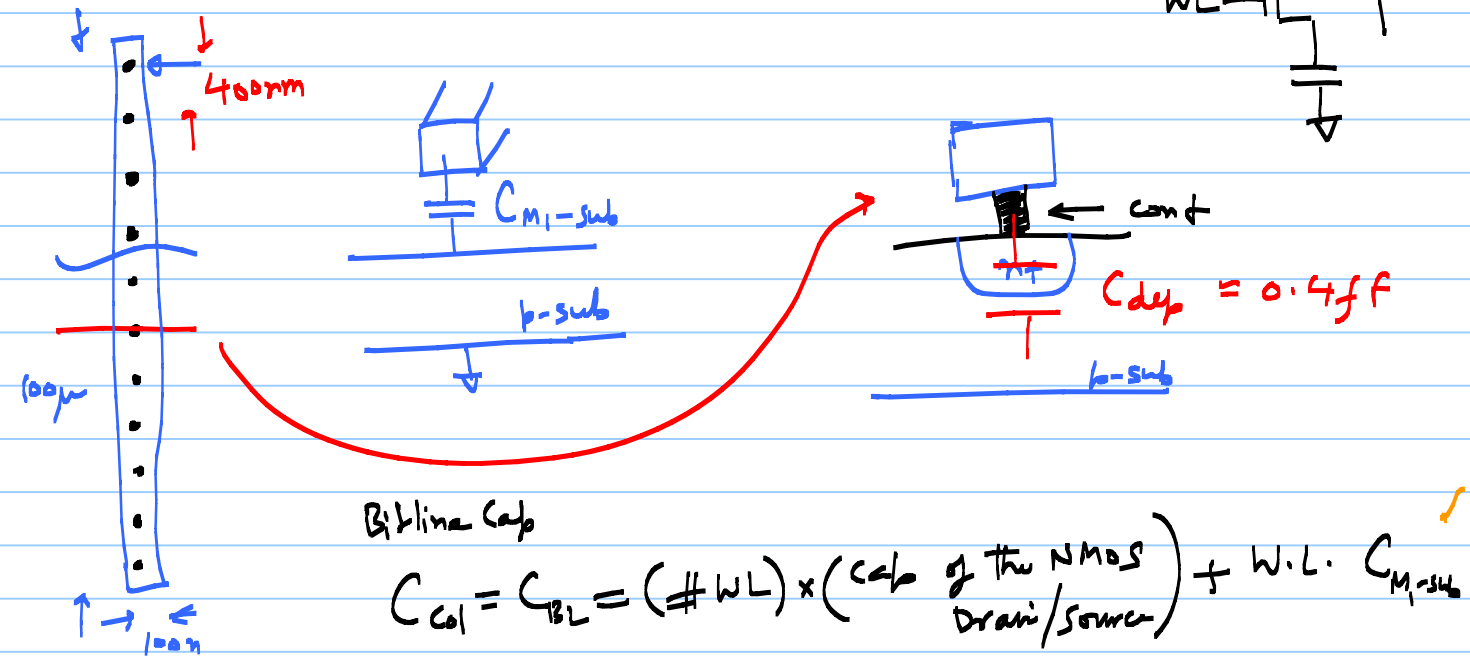
ECE 518 – Lecture 2

Note Title 1/24/2013



Bitline Cap

$$C_{col} = C_{BL} = (\#WL) \times \left(\text{cap of the NMOS drain/source}\right) + W \cdot L \cdot C_{M_1\text{-sub}}$$

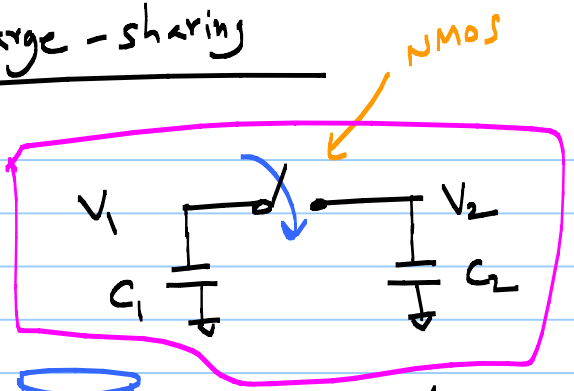
$\#WL = 250$

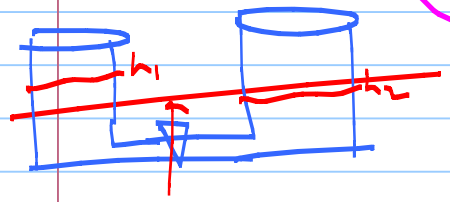
$$= 250 \times 0.4f + \frac{0.1}{\mu m} \times \frac{100}{\mu m} \times 100 \frac{fF}{\mu m^2}$$

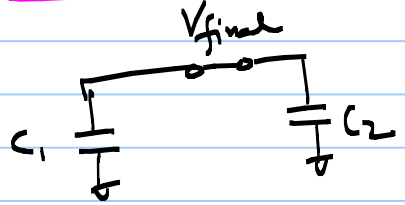
$$= 100f + 1f$$

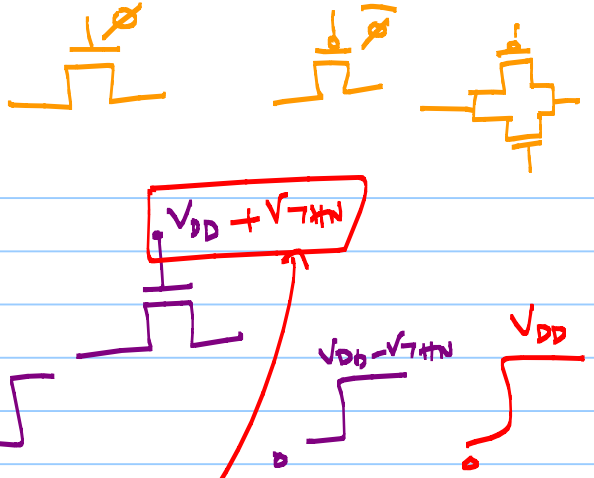
$$\hookrightarrow \boxed{100fF}$$

charge-sharing









$$Q_i = Q_f$$

$$C_1V_1 + C_2V_2 = (C_1+C_2)V_{final}$$

weighted average

$$V_{final} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

$V_1 = V_{DD} = 1V$

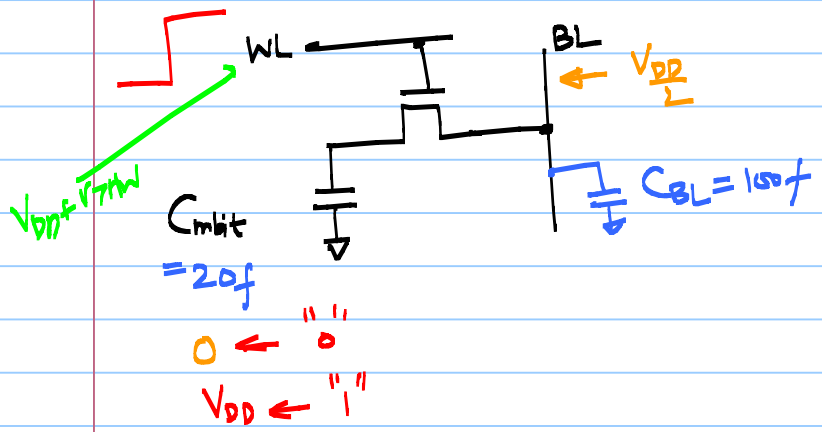
$V_2 = 0\,V$

$$V_{final} = \left(\frac{C_1}{C_1 + C_2}\right) V_{DD}$$

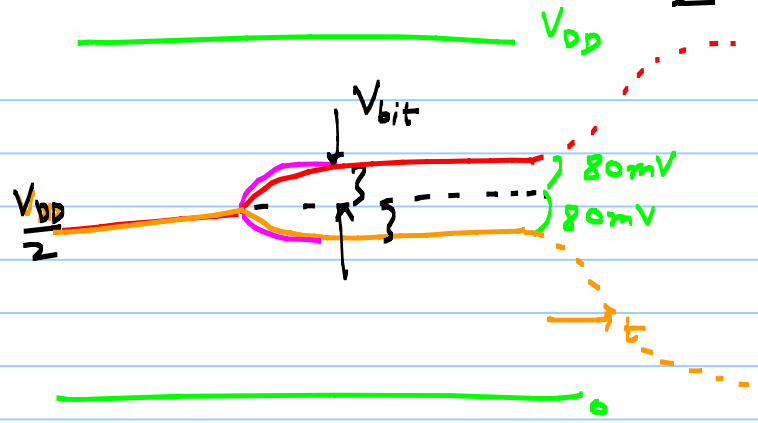
for $C_1 = \frac{C_2}{9}$ $= \frac{1}{10} \cdot V_{DD} = 0.1\,V$

Sensing:

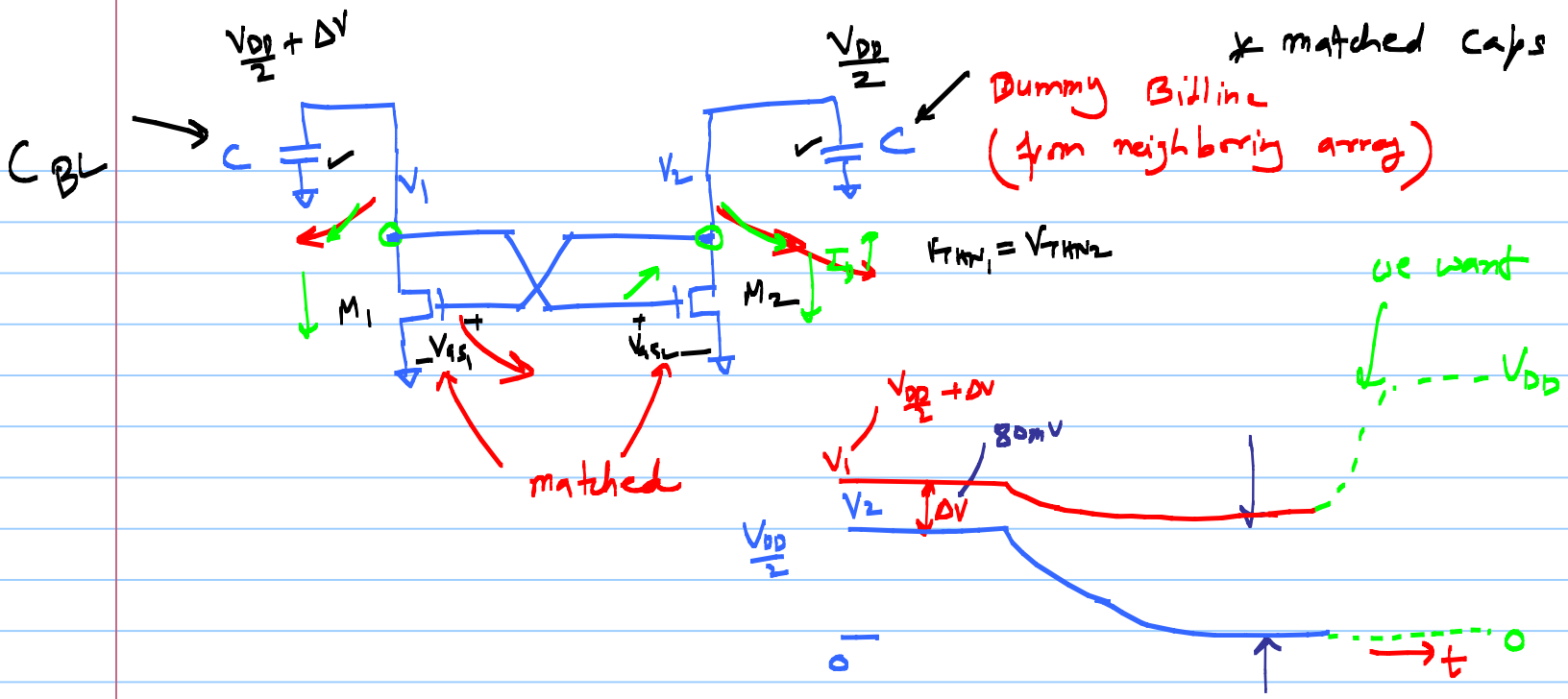
1TIC DRAM Cell



We precharge BL's to $\frac{V_{DD}}{2}$



* Need a sense amp to further drive BL's to full rails


$\frac{V_{DD}}{2} + \Delta V$
$\frac{V_{DD}}{2}$
* matched caps
C_{BL}
C
C
Dummy Bitline
(from neighboring array)
V_1
V_2
I_2
$V_{THN_1} = V_{THN_2}$
M_1
M_2
V_{GS_1}
V_{GS_2}
matched
we want
V_{DD}
$\frac{V_{DD}}{2} + \Delta V$
80mV
V_1
V_2
ΔV
$\frac{V_{DD}}{2}$
0
t
0

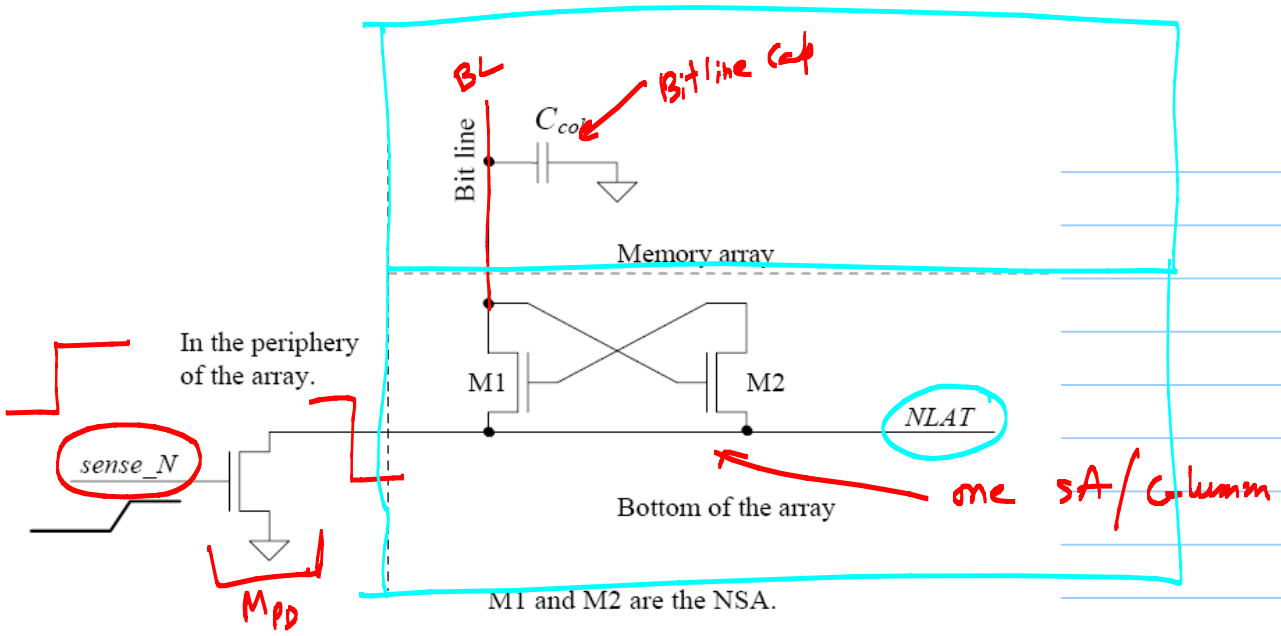


Figure 16.5 Development of an NMOS sense amplifier (NSA).

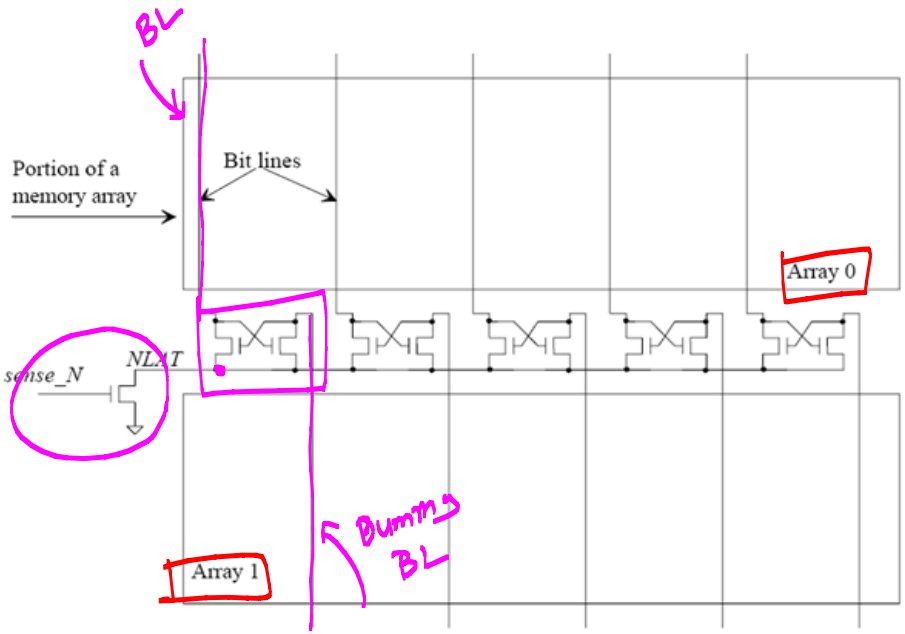
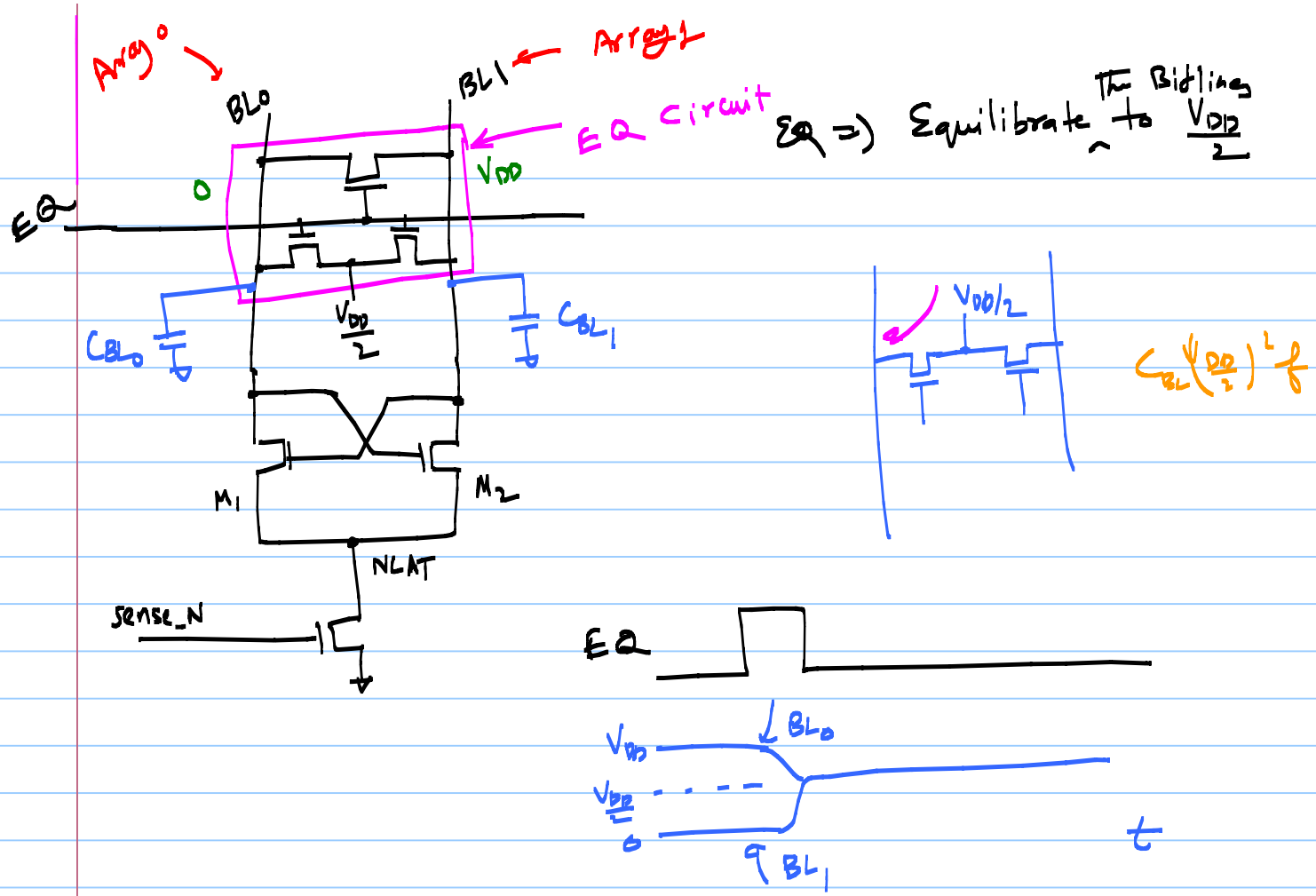


Figure 16.6 How the NSA is placed between two memory arrays in the so-called open memory array architecture.

open-array
Architecture



EQ => Equilibrate the Bitlines to $\frac{V_{DD}}{2}$

$C_{BL}\left(\frac{V_{DD}}{2}\right)^2 f$

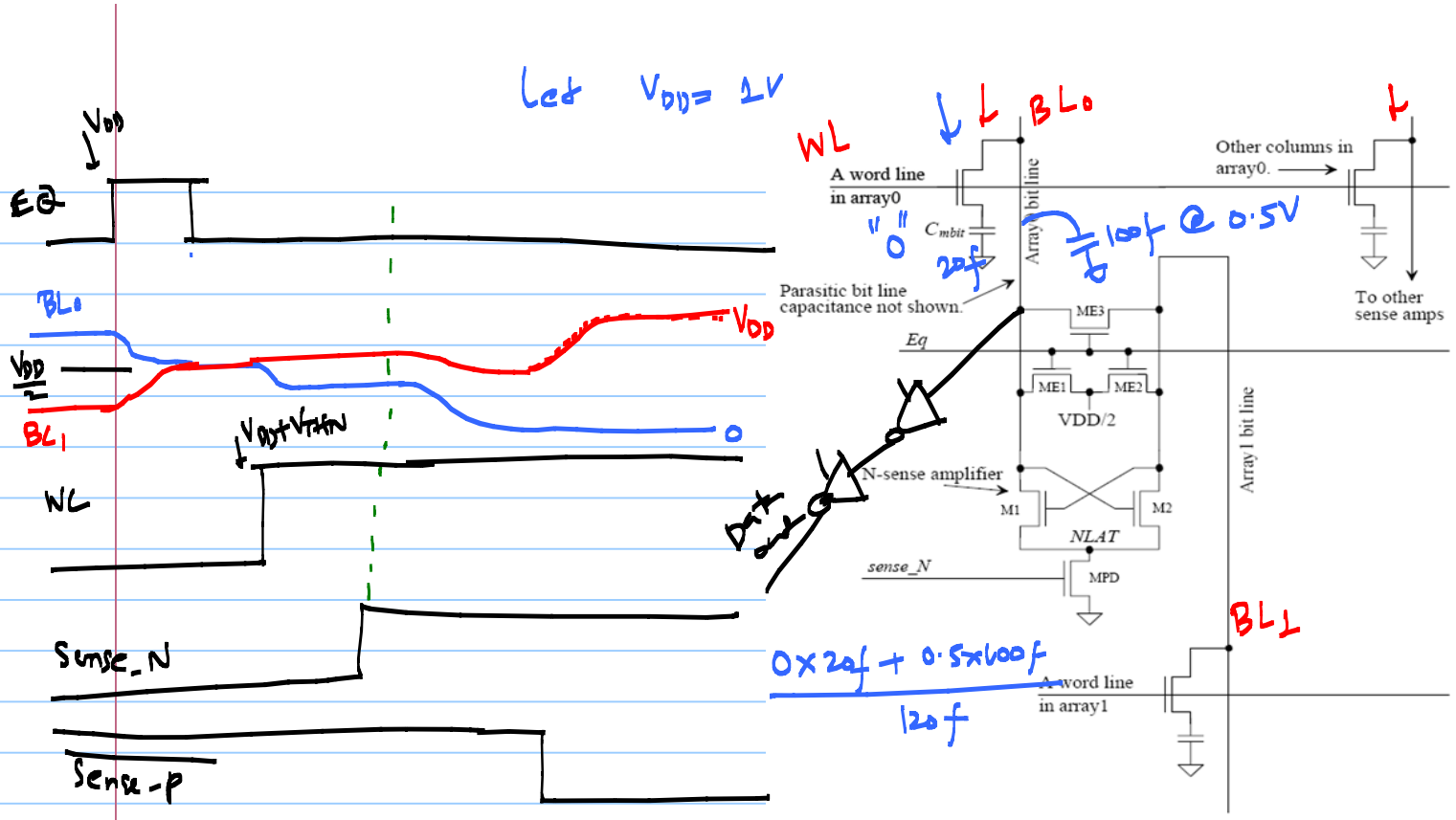
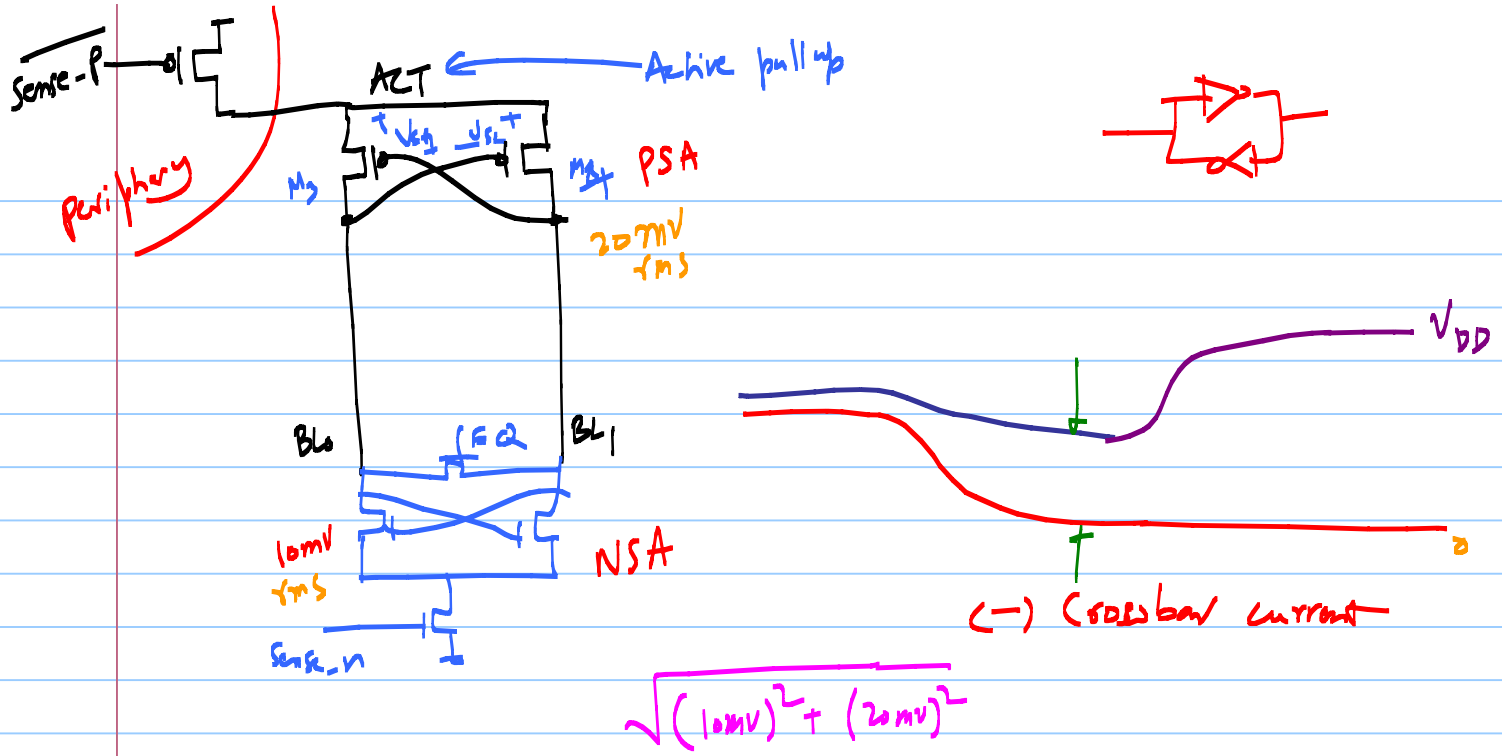


Figure 16.10 The connection of the NSA to the memory arrays.



$$\sqrt{(10mV)^2 + (20mV)^2}$$

$C_{mbit} \leftarrow 0, \quad V_{DD} \leftarrow V_{mbit}$

$C_{BL} \leftarrow \frac{V_{DD}}{2}$

After charge sharing

$$V_{final} = \frac{C_{mbit} \cdot V_{mbit} + C_{BL} \cdot \frac{V_{DD}}{2}}{C_{mbit} + C_{BL}}$$

$$\Delta V_{BL} = V_{final} - \frac{V_{DD}}{2} = \frac{C_{mbit}}{C_{mbit} + C_{BL}} \left(V_{mbit} - \frac{V_{DD}}{2} \right)$$

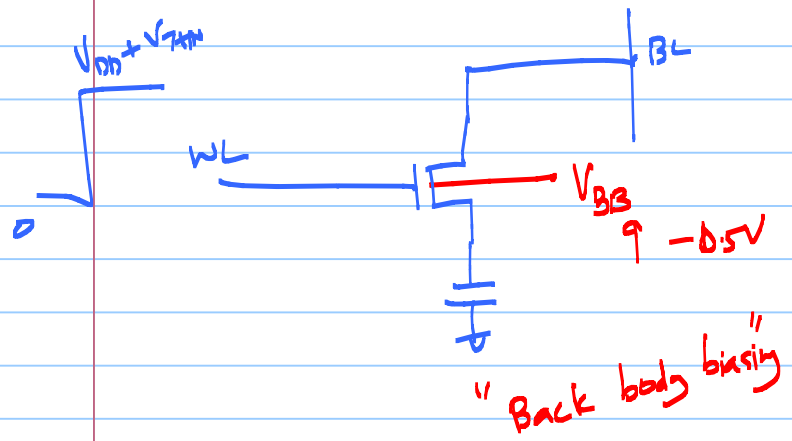
2nf

$$\pm \left(\frac{C_{mbit}}{C_{mbit} + C_{BL}} \right) \frac{V_{DD}}{2}$$

$\#WL \cdot C_{dup}$

$$P_{avg} = (\#SA) \cdot C_{BL} \cdot \left(\frac{V_{DD}}{2}\right)^2 \cdot f_{Read}$$

* Self refreshing ready



$V_{SB} < 0 \Rightarrow V_{THN} > V_{THN_0}$