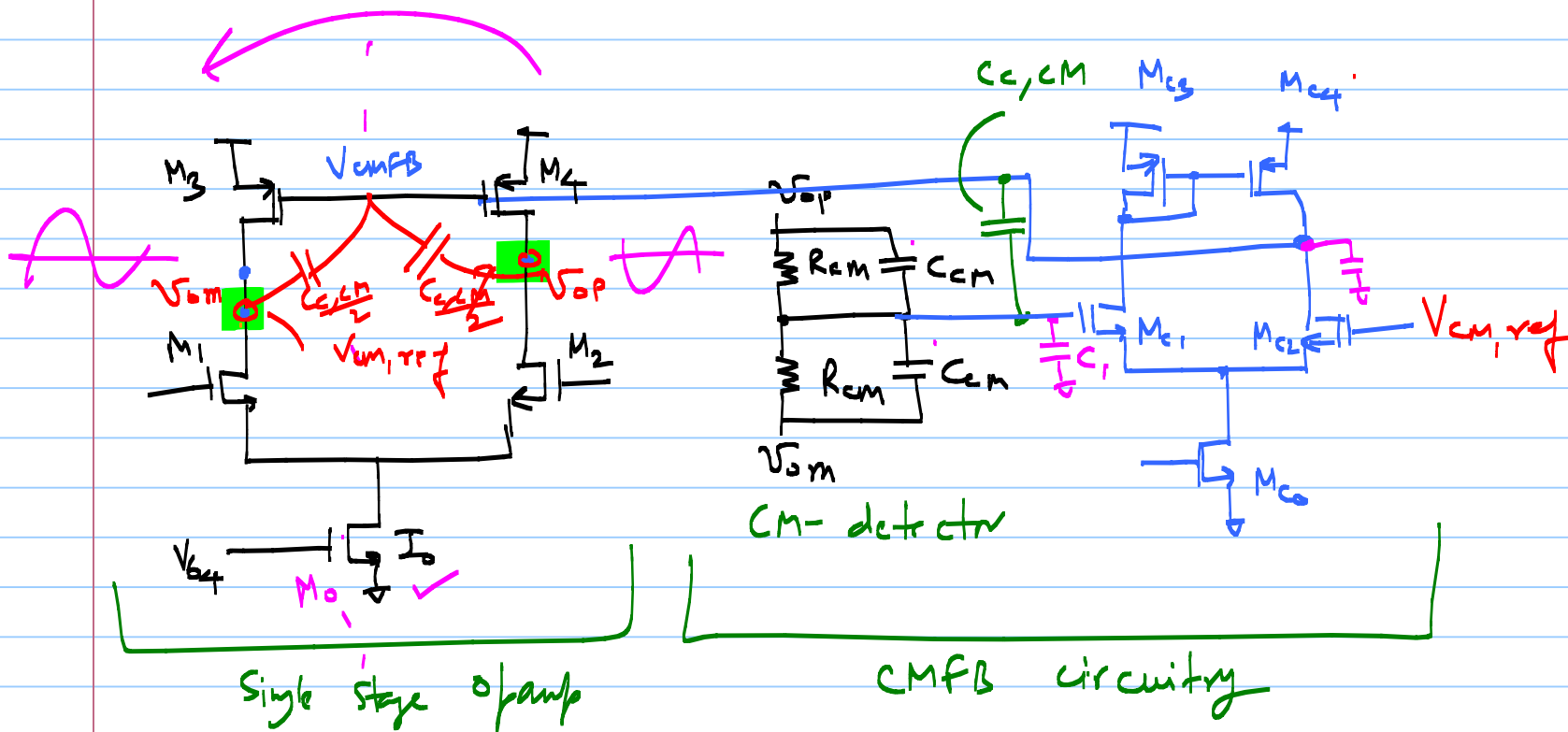


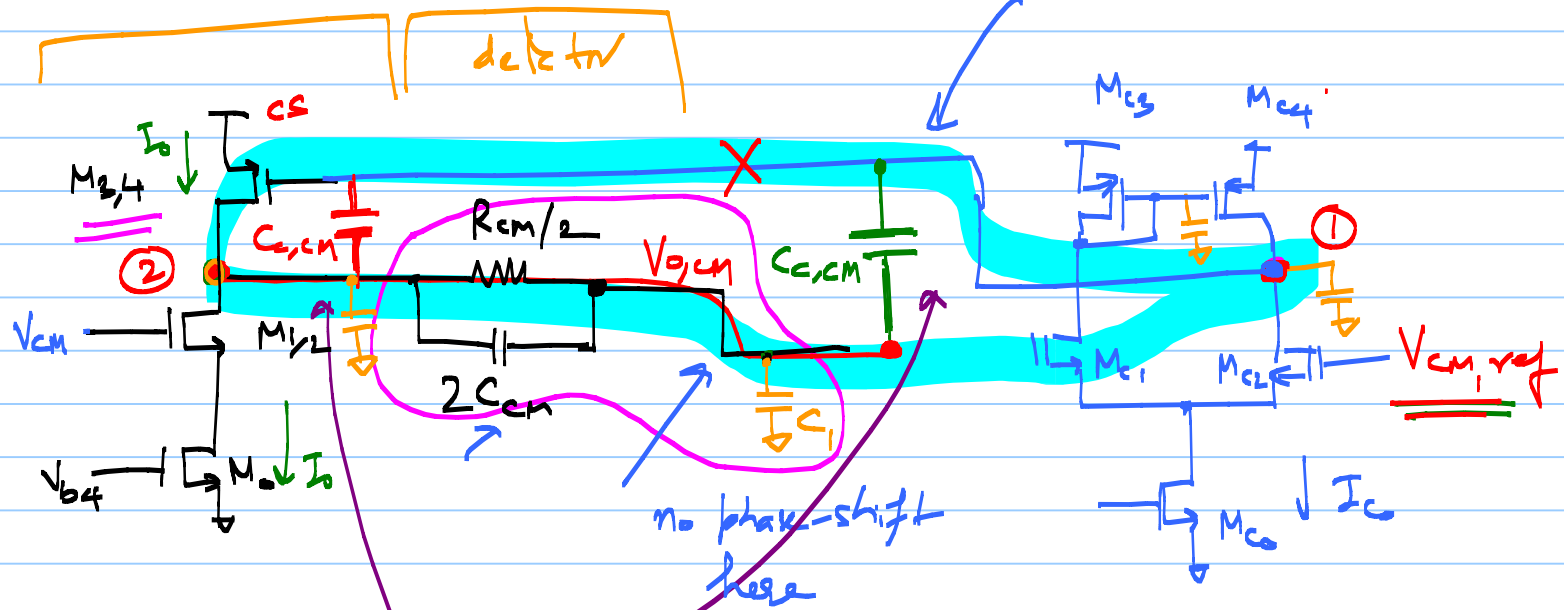
9/5/2012



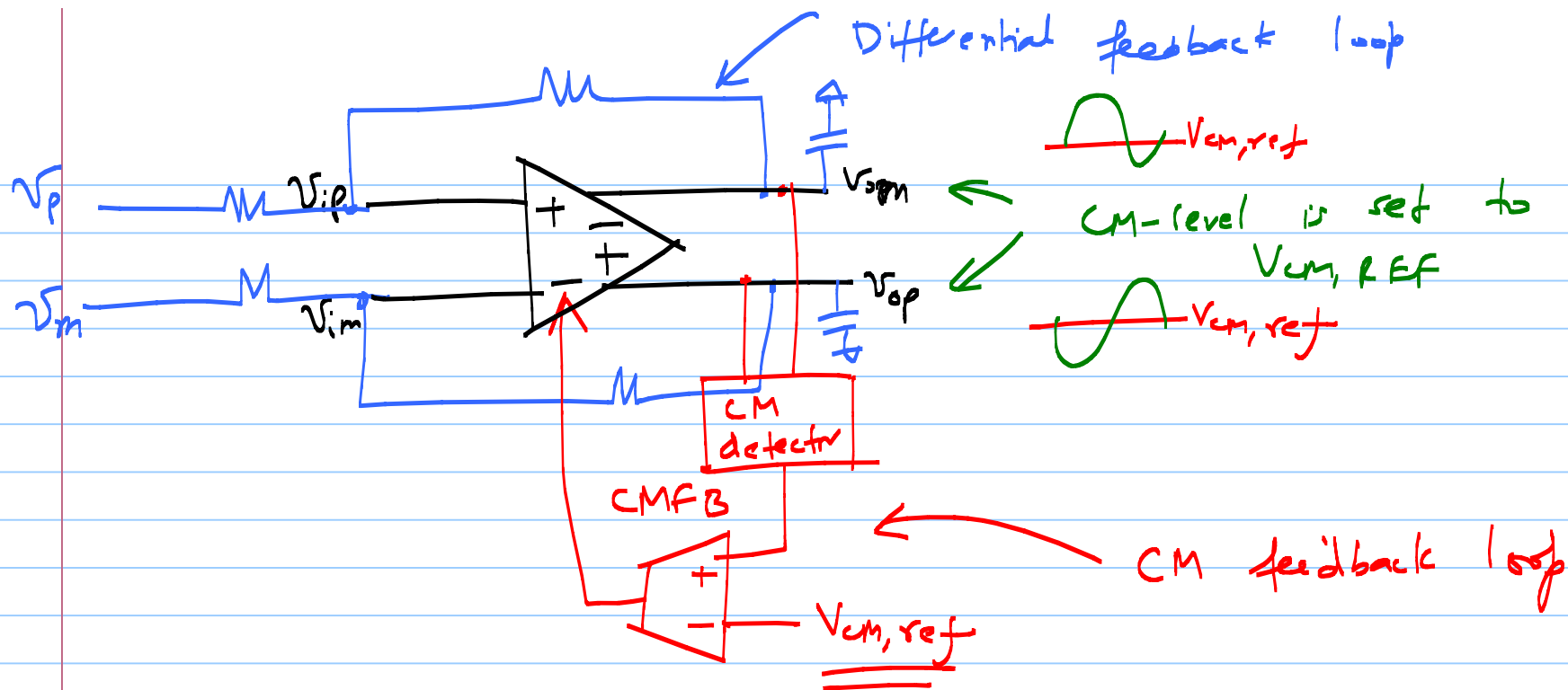
CM picture for Diff Amp

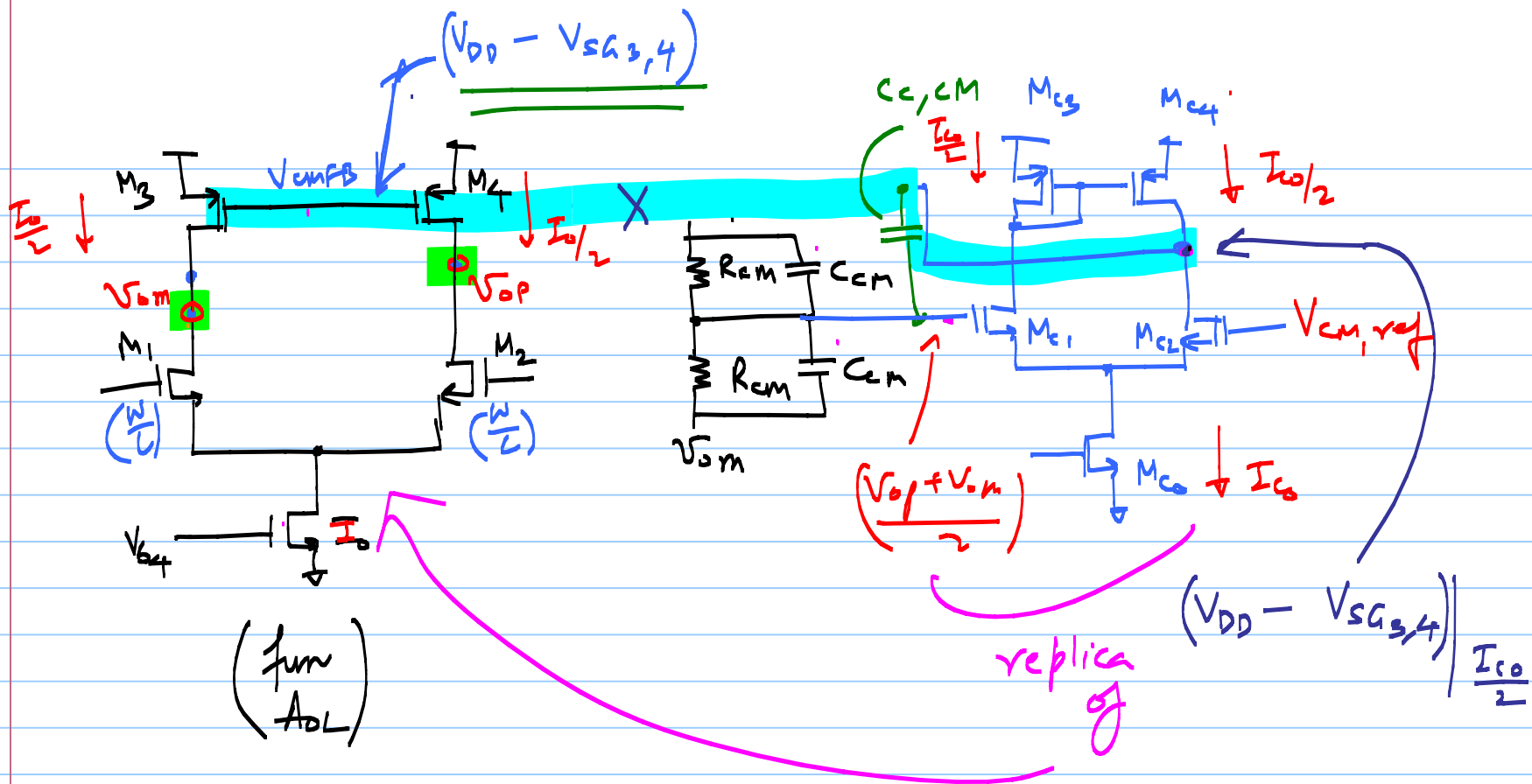
delete tv

"CMFB"



$\hat{=} \frac{V_{DD}}{2}$
'let's say'





when the CMFB loop is balanced

$V_{cmFB} \Rightarrow$ goes from

$$\left(V_{DD} - V_{SG_{3,4}} \left| \frac{I_{C0}}{2} \right. \right) \quad \text{to} \quad \left(V_{DD} - V_{SG_{3,4}} \left| \frac{I_{C0}}{2} \right. \right)$$

If these two voltages are not equal $\Rightarrow$ systematic offset in the loop

$$\underbrace{\left(\frac{V_{op} + V_{om}}{2} \right)}_{\text{cm-level}} - \underbrace{V_{cm,ref}}_{\text{desired}} \xrightarrow{\text{loop gain}} \frac{\left(V_{DD} - V_{SG_{3,4}} \left| \frac{I_{C0}}{2} \right. \right) - \left(V_{DD} - V_{SG_{3,4}} \left| \frac{I_{C0}}{2} \right. \right)}{\text{loop gain}}$$

systematic offset error $= \frac{V_{int}}{A}$

To avoid systematic offset

$$V_{DD} - V_{S_{3,4}} \Big|_{\frac{I_0}{2}} \stackrel{\Delta}{=} V_{DD} - V_{S_{C3,4}} \Big|_{\frac{I_0}{2}}$$

$\Rightarrow$ Length of $M_{C3}, M_{C4} = \text{Length of } M_3, M_4$

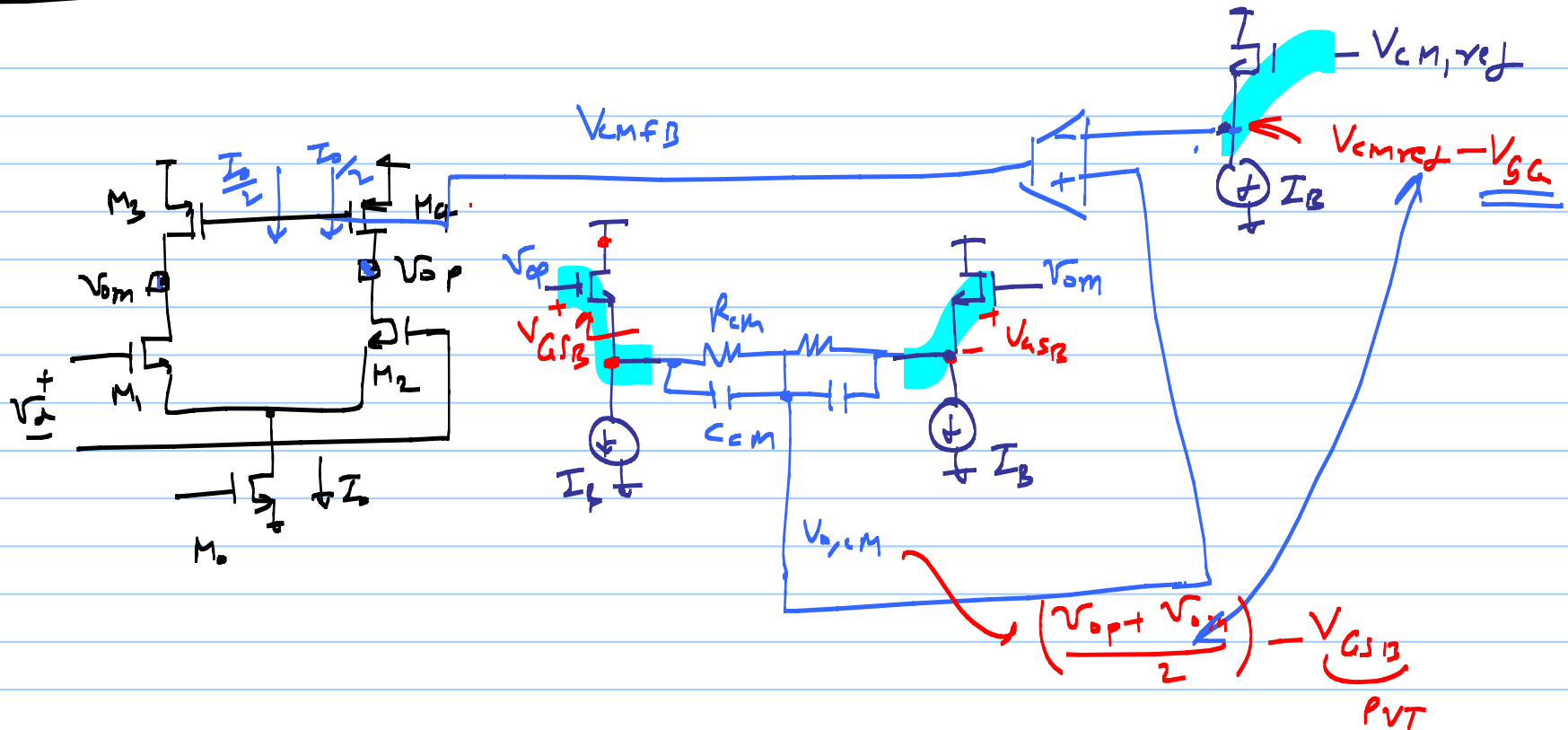
$$\frac{W_{3,4}}{(I_0/2)} = \frac{W_{C3,4}}{(I_0/2)} \Leftarrow \begin{array}{l} \text{keeping the current} \\ \text{density the same} \end{array}$$

 make the current densities

Summary:

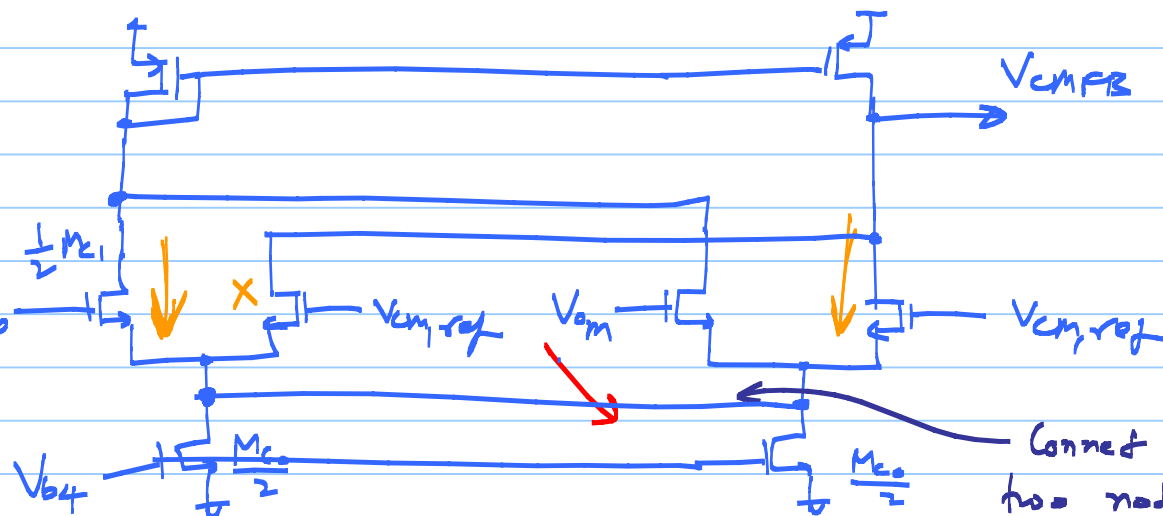
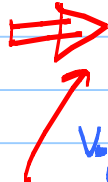
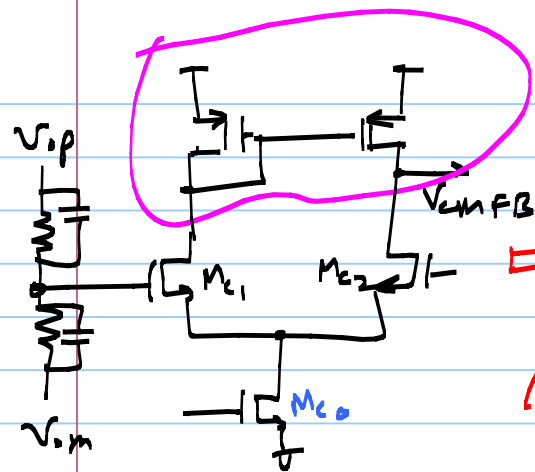
- * The CMFB loop looks like the two-stage opamp
 - ↳ Need to compensate (Always!)
 - ↳ Analyze the CM equivalent circuit
 - ↳ any element in the differential path needs to be split appropriately in the final circuit
 - ↳ Ensure by design $\Rightarrow$ No systematic offset

problem: loading of differential opamp by the resistive cm-detector:

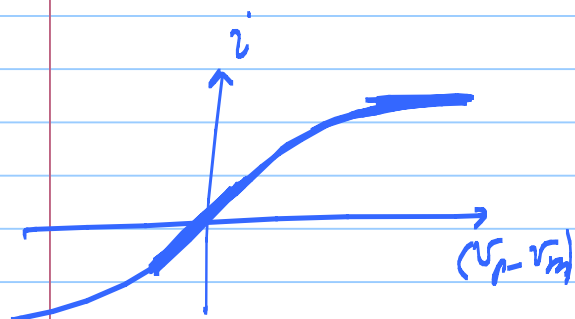


$$\begin{aligned}
 -i_{c2} = i_{c1} &= \frac{g_{m1}}{2} \left[\underbrace{\left(\frac{v_{op} + v_{om}}{2} \right) - v_{cm,ref}}_{\text{diff-pair}} \right] \\
 &= \frac{g_{m1}}{2} \left(\frac{v_{ip}}{2} - \frac{v_{cm,ref}}{2} \right) + \frac{g_{m1}}{2} \left(\frac{v_{om}}{2} - \frac{v_{cm,ref}}{2} \right) \\
 &= \frac{g_{m1}}{4} \left(\underbrace{v_{op} - v_{cm,ref}}_{\text{diff-pair}} \right) + \frac{g_{m1}}{4} \left(\underbrace{v_{om} - v_{cm,ref}}_{\text{diff-pair}} \right)
 \end{aligned}$$

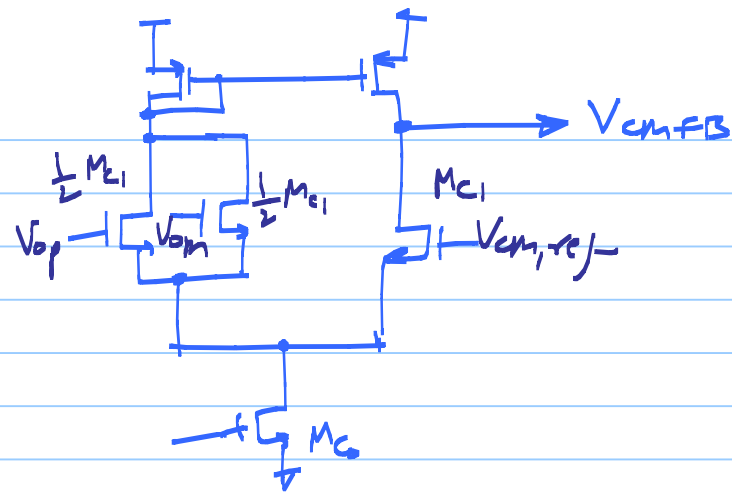
↑ All for small-signals



Connect these two nodes for slightly better linearity



Dual - Diffamp CM-detector
 * Input impedance high (∞)



CMOS Book

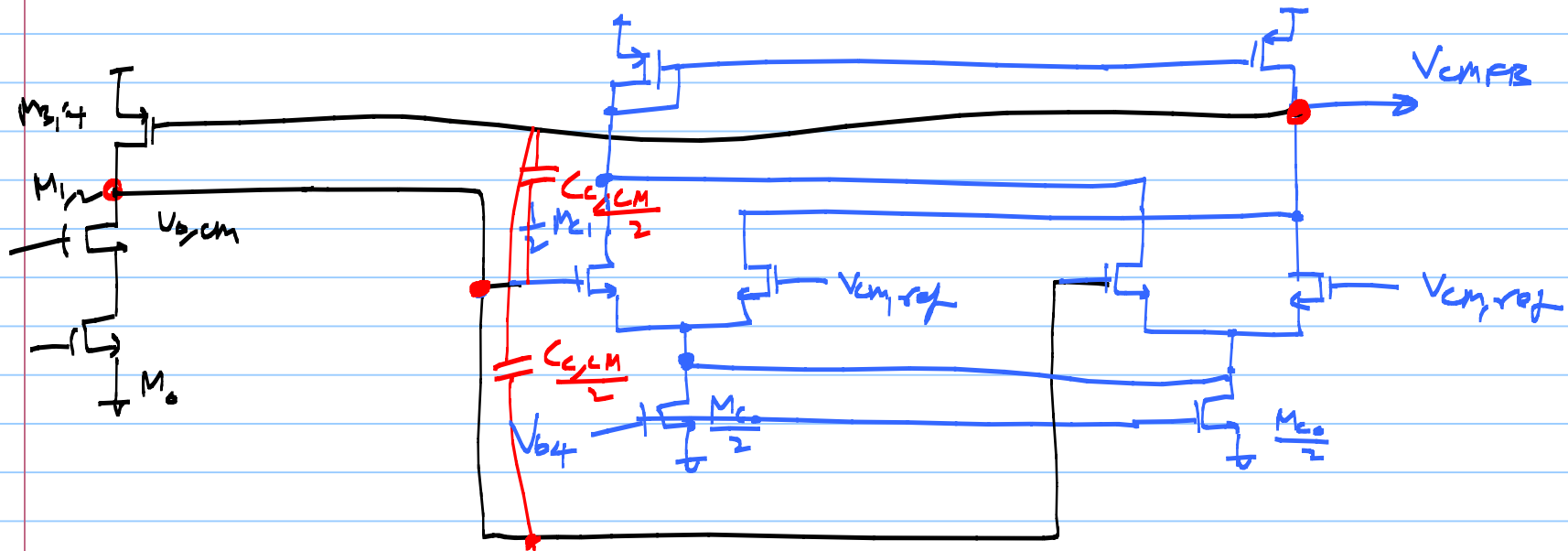
* Size for No systematic offset

↳ match the current densities.

(+) doesn't load the differential amplifier

(-) for large swings, the CM detection is "non-linear"

cm picture



* gain stage is loaded