Other Topologies

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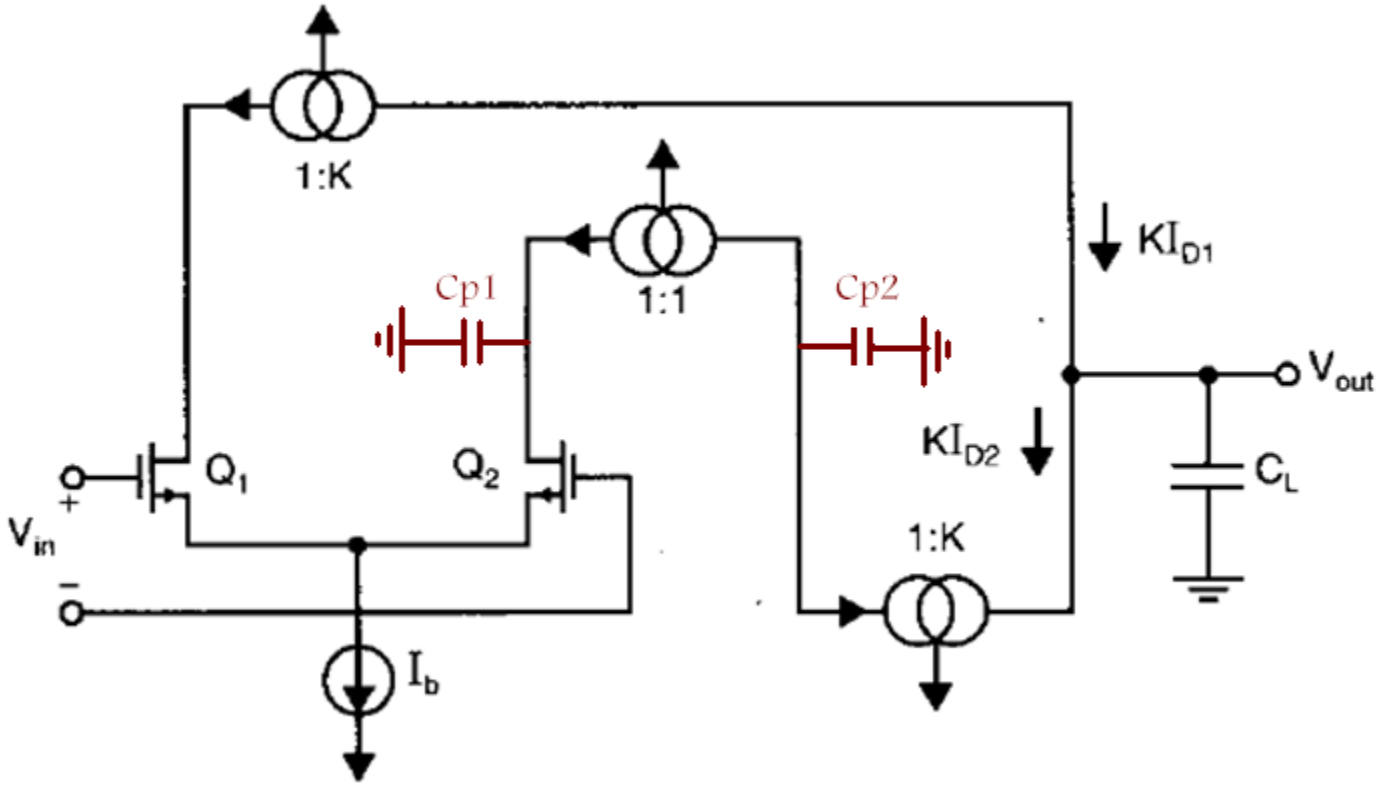
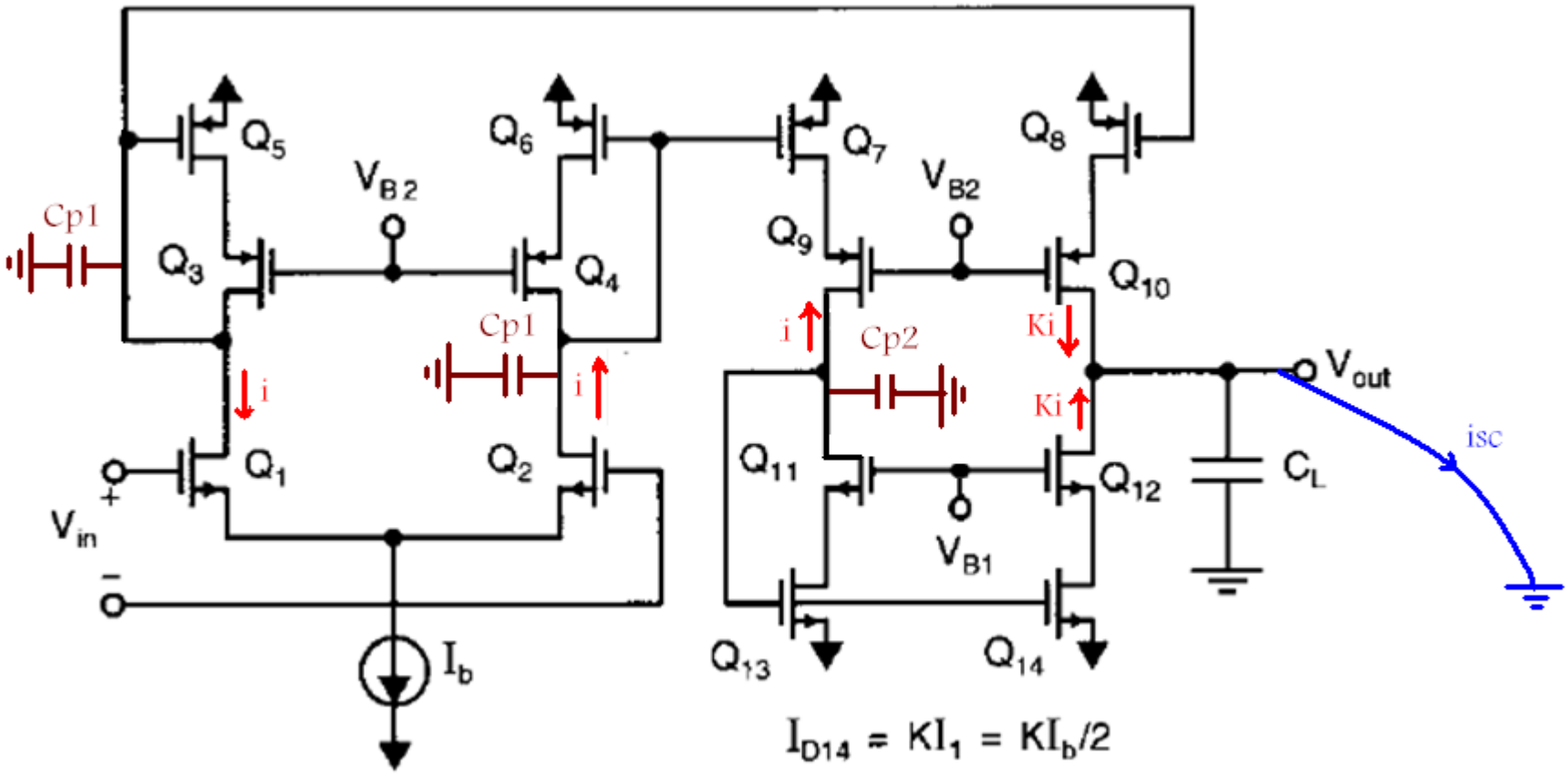
Single-Ended Current-Mirror Opamp

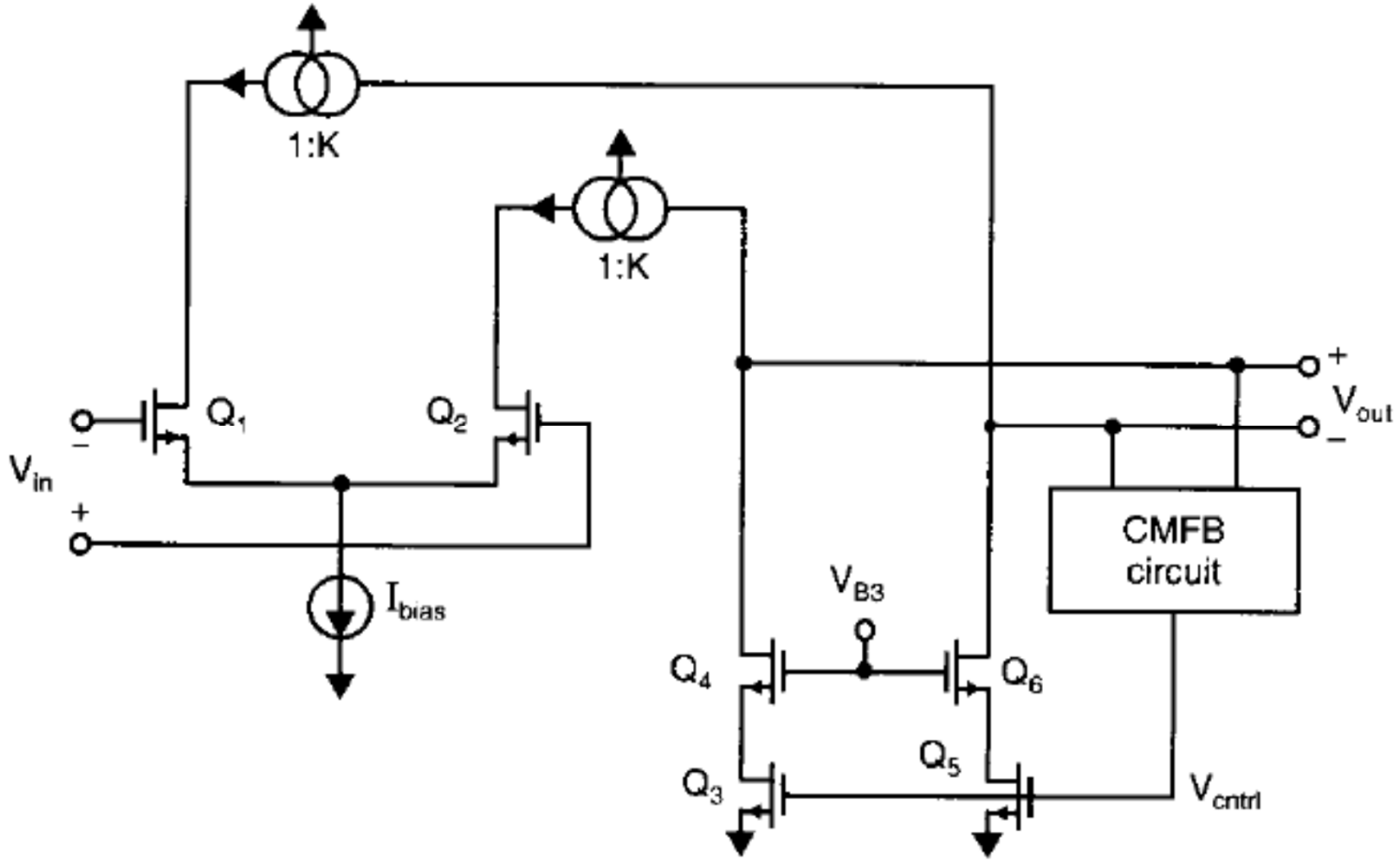


Current-Mirror Opamp with Wide-Swing Cascode Current Sources

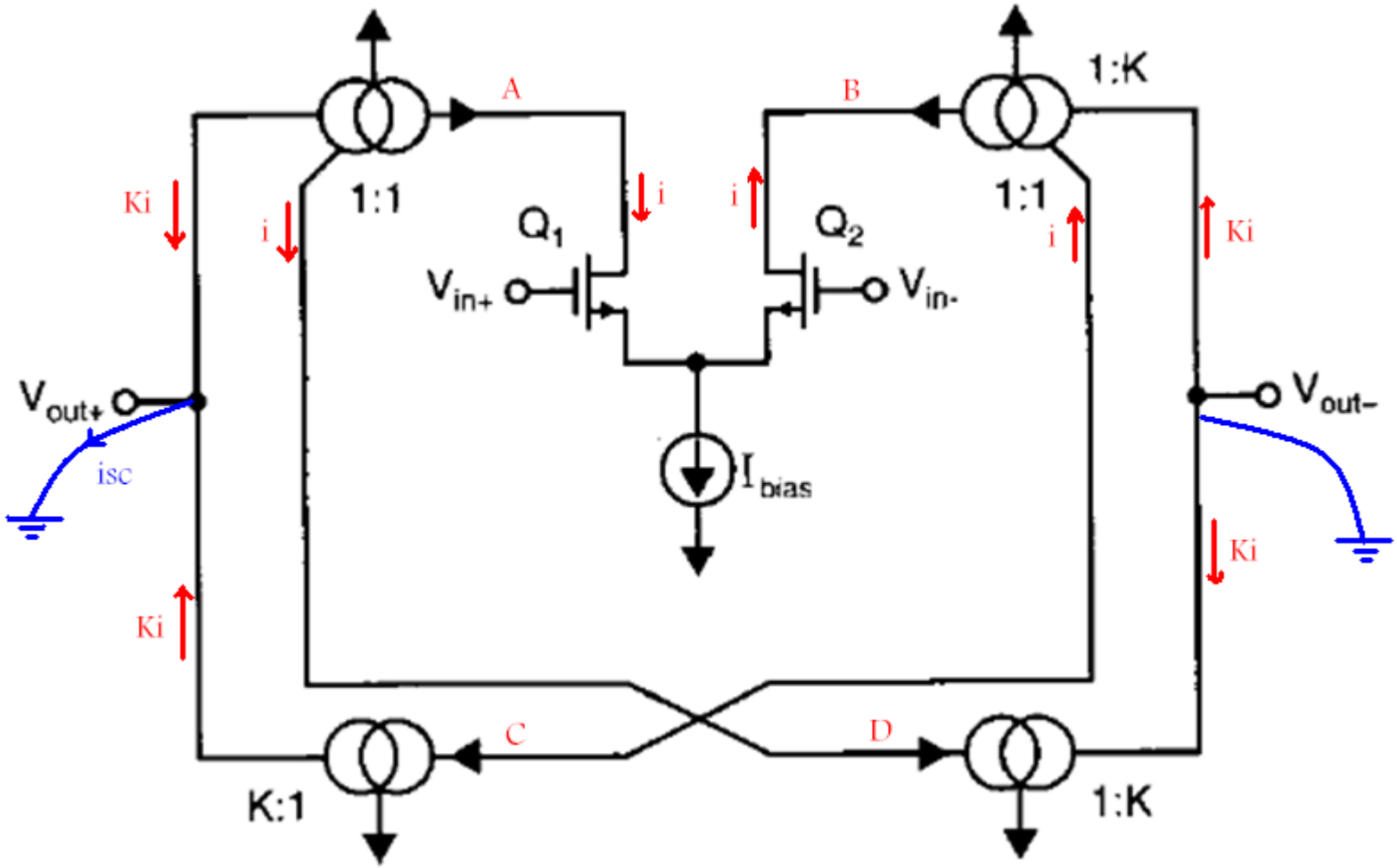


$$I_{D14} = KI_1 = KI_b/2$$

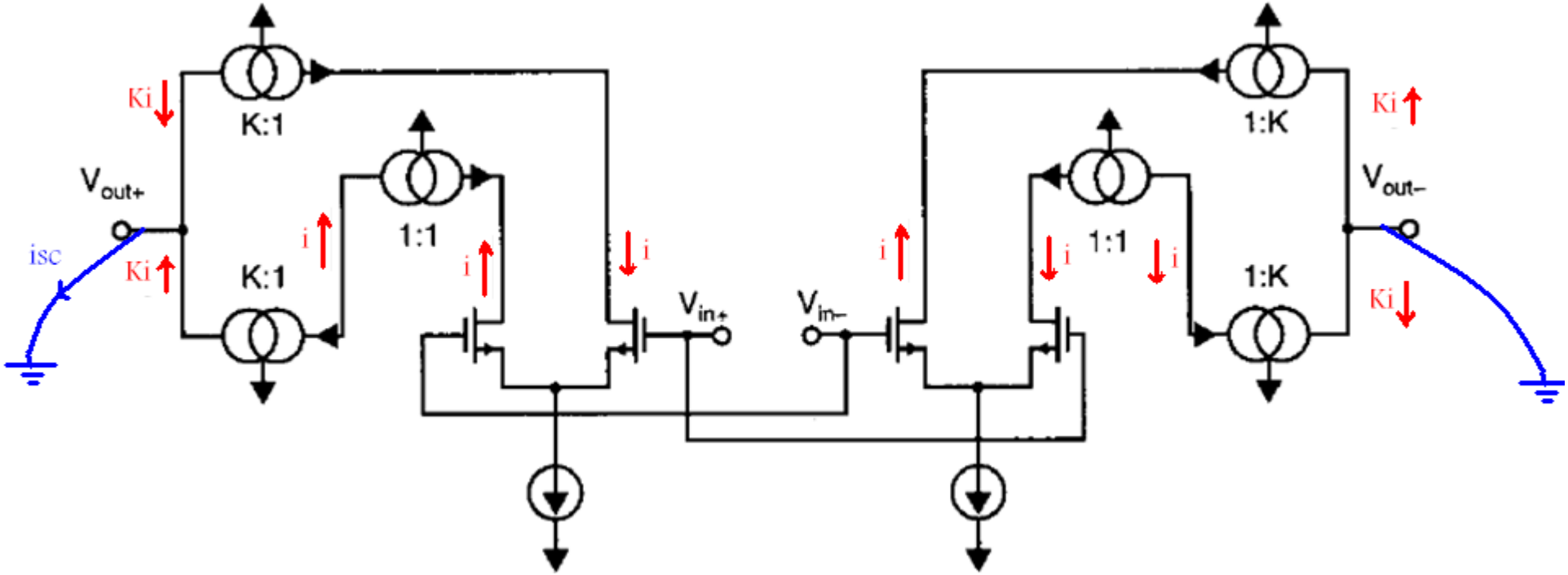
Fully Differential Current-Mirror Opamp



Fully Differential Opamp with Bidirectional Output Drive.



Fully Differential Opamp Composed of Two Single-Ended Output Current-Mirror Opamps



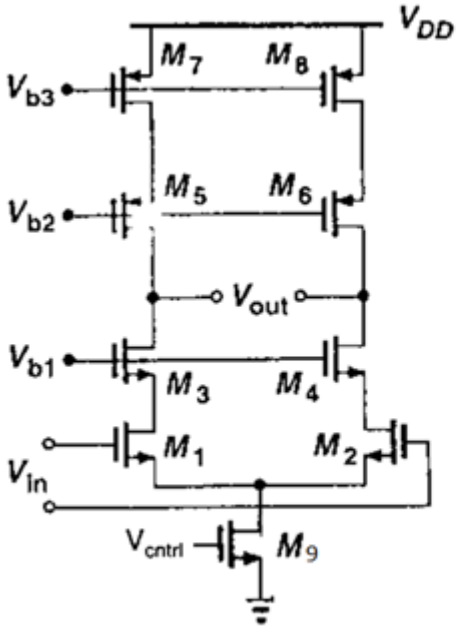
Common-Mode Feedback Circuits

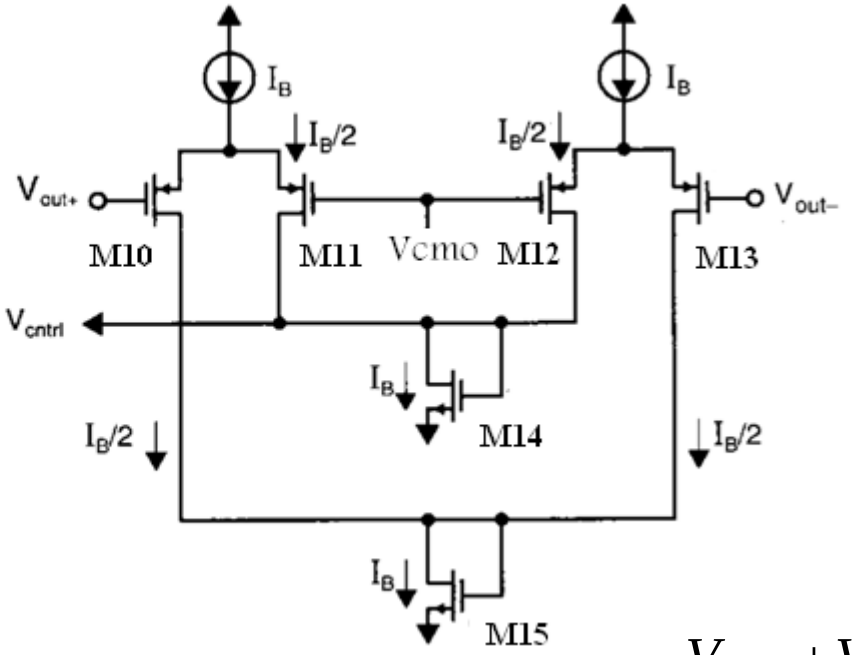
Common-mode-feedback (CMFB) circuitry is often the most difficult part of the opamp to design.

There are two types of CMFB circuit:

- ❖Continuous-time CMFB
- ❖Discrete-time CMFB

Continuous-time CMFB Circuit



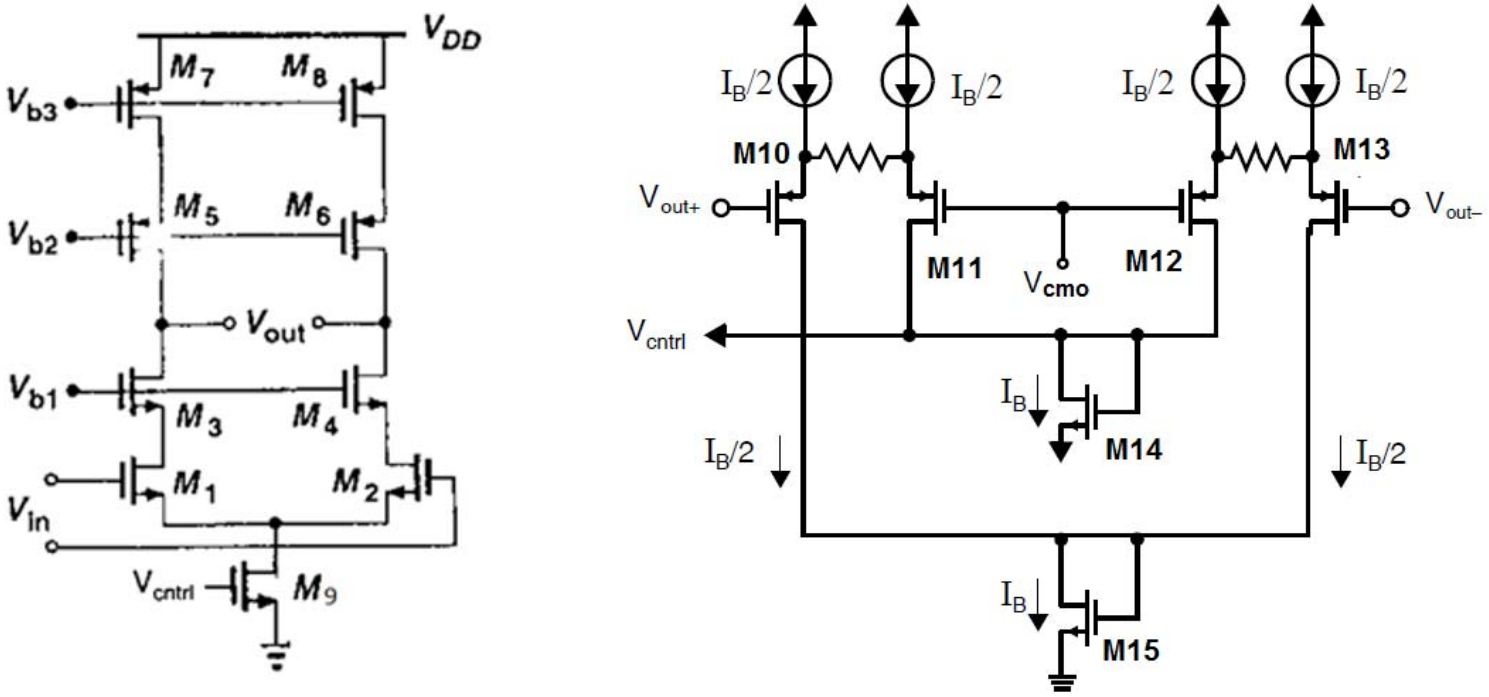


Vcmo denotes the desired output common-mode voltage. $v_{err} = \dfrac{V_{out+} + V_{out-}}{2} - V_{cmo}$

Small-signal analysis

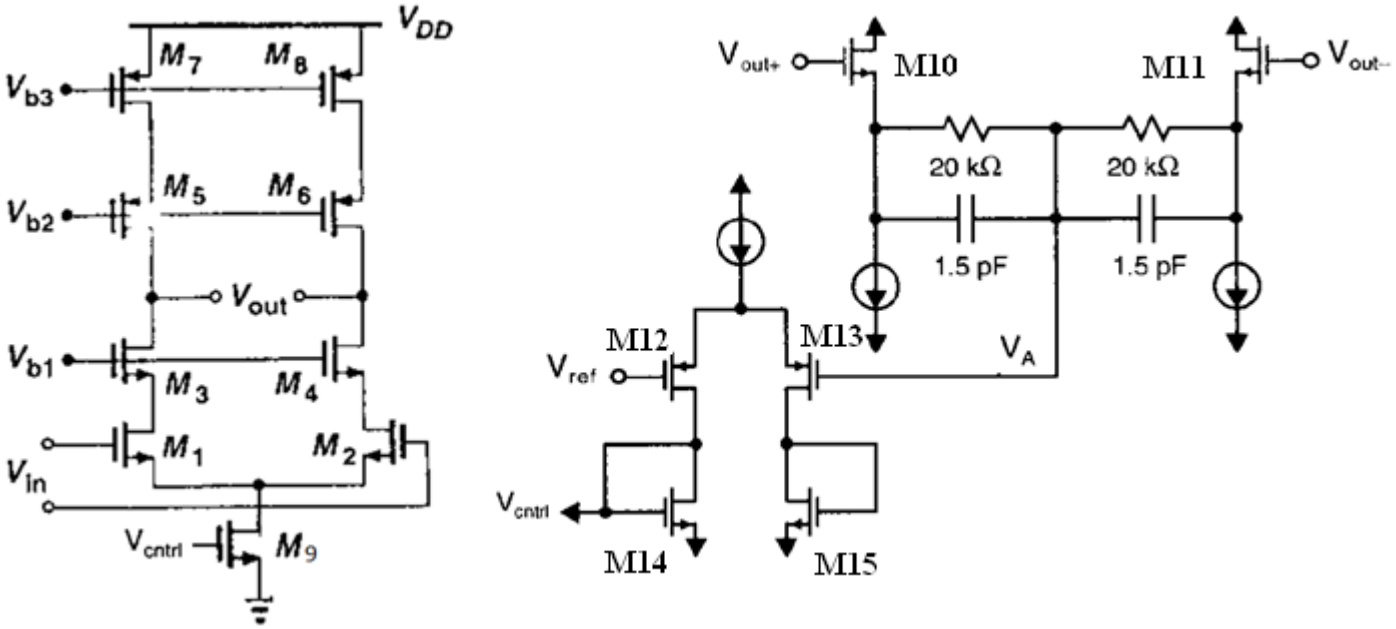
$$\left.\begin{aligned} &\frac{v_{ctrl}}{v_{err}} = \frac{g_{m10}}{g_{m14}} \\ &\frac{v'_{err}}{v_{ctrl}} \cong -\frac{1}{2} g_{m9} R_{out} \\ &R_{out} \cong g_{m6} r_{ds6} r_{ds8} \end{aligned}\right\} \Rightarrow loop\ gain = \frac{v'_{err}}{v_{err}} = -\frac{g_{m10} g_{m9} g_{m6}}{2 g_{m14}} r_{ds6} r_{ds8}$$

Continuous-time CMFB Circuit



A continuous-time CMFB circuit that can accommodate increased output swing.

Continuous-time CMFB Circuit



$$V_A = V_{CM} - V_{eff10} - V_{tn}$$

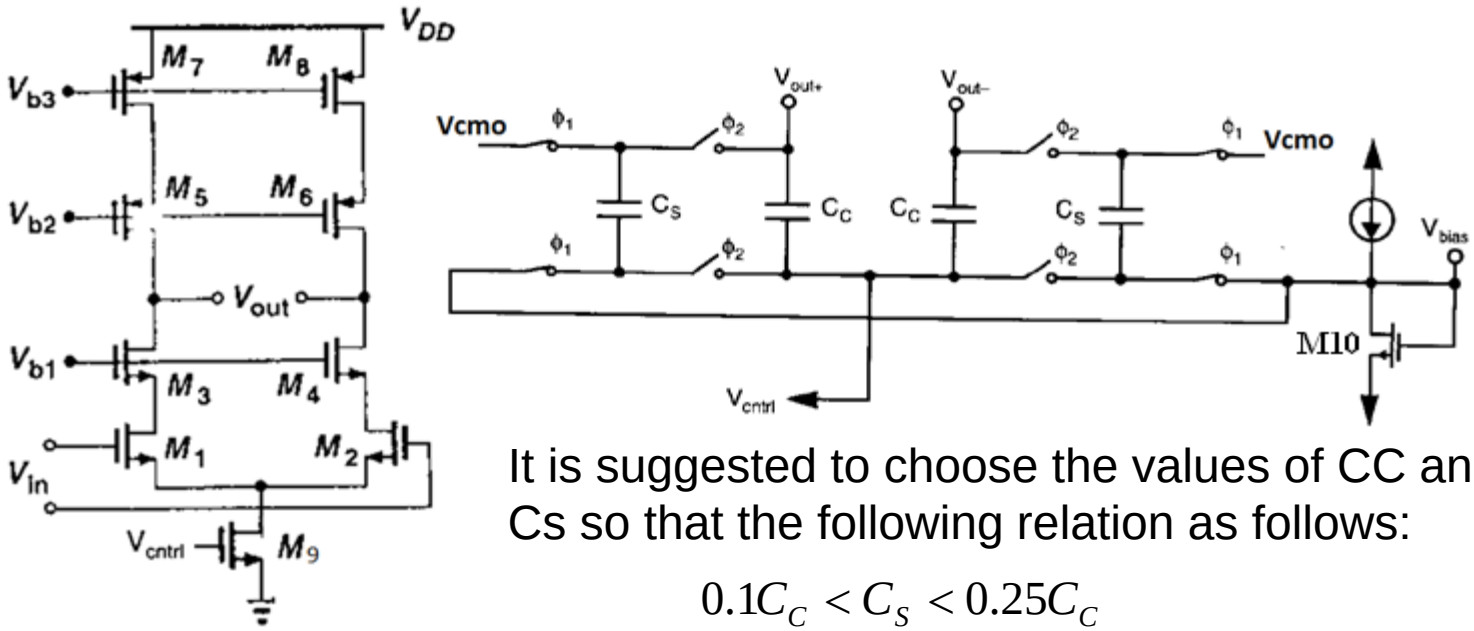
$$V_{ref} = V_{CMO} - V_{eff10} - V_{tn}$$

$$v_{err} = \frac{V_{out+} + V_{out-}}{2} - V_{cmo}$$

Small-signal analysis

$$\left.\begin{aligned} \frac{v_{ctrl}}{v_{err}} &= \frac{g_{m13}}{2g_{m14}} \\ \frac{v'_{err}}{v_{ctrl}} &\cong -\frac{1}{2} g_{m9} R_{out} \\ R_{out} &\cong g_{m6} r_{ds6} r_{ds8} \end{aligned}\right\} \Rightarrow loop\ gain = \frac{v'_{err}}{v_{err}} = -\frac{g_{m13} g_{m9} g_{m6}}{4g_{m14}} r_{ds6} r_{ds8}$$

Discrete-time CMFB Circuit



It is suggested to choose the values of CC and Cs so that the following relation as follows:

$$0.1C_C < C_S < 0.25C_C$$

Performing a few manipulations, we have:

$$V_{CM}(z) = \frac{V_{out+}(z) + V_{out-}(z)}{2}$$

$$V_{ctrl}(z) = \frac{\frac{C_S}{C_S + C_C} z^{-1}}{1 - \frac{C_C}{C_S + C_C} z^{-1}} \left(V_{bias}(z) - V_{cmo}(z)\right) + V_{CM}(z)$$