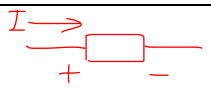
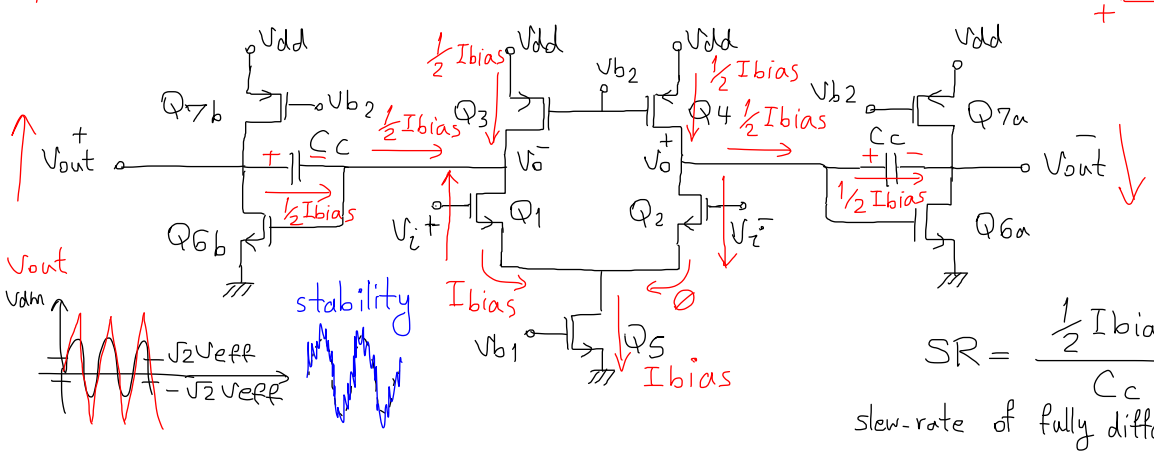
*Slew-rate

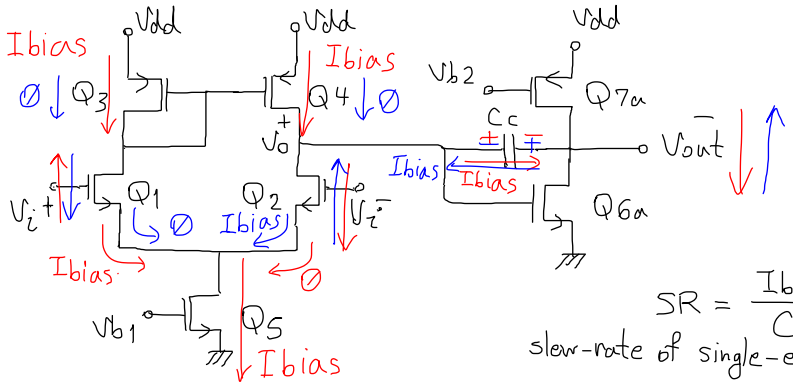
$Q = CV = I \cdot t$





$$SR = \frac{\frac{1}{2}Ibias}{C_c} = \frac{\Delta V}{t}$$

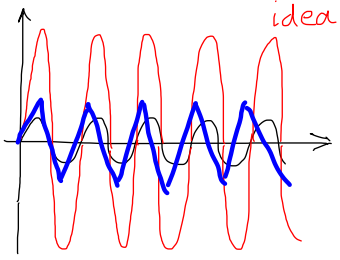
slew-rate of fully differential amplifier



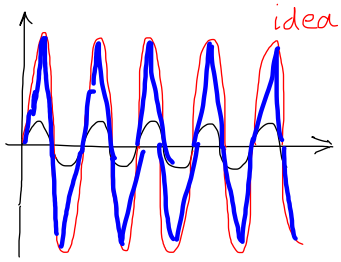
$$SR = \frac{Ibias}{C_c}$$

slew-rate of single-ended amplifier

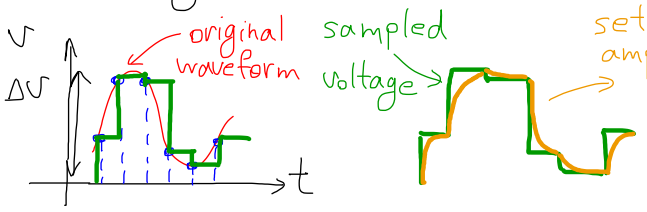
*opamps with small slew-rate $1\,V/\mu s$, $SR = \frac{\Delta V}{t} = \frac{I}{C}$

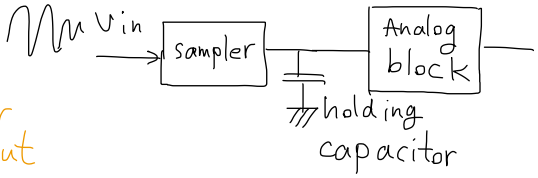


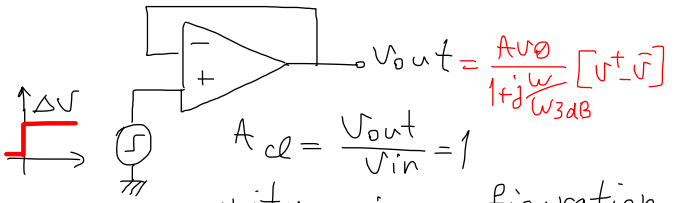
*opamps with large slew-rate $10\,V/\mu s$, $SR = \frac{\Delta V}{t} = \frac{I}{C}$



* Settling time (t_s):

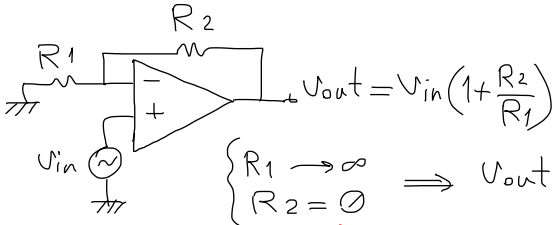




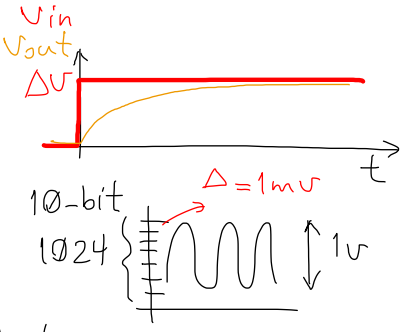


$$A_{cl} = \frac{V_{out}}{V_{in}} = 1$$

unity gain configuration



$$\begin{cases} R_1 \to \infty \\ R_2 = 0 \end{cases} \Rightarrow V_{out} = V_{in}$$



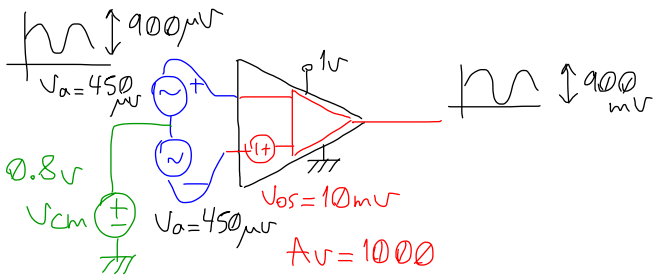
$$V_{out}(t) = V_{out}(\infty) - \left[V_{out}(\infty) - V_{out}(0)\right] e^{-\frac{t}{\tau}}$$

($V_{out}(\infty) = \Delta V$, $V_{out}(0) = 0$)

$$V_{out}(t) = \Delta V\left(1 - e^{-\frac{t}{\tau}}\right), \quad \tau = \frac{1}{\omega_{P1}}$$

if

- $V_{out} = 90\%\ \Delta V \Rightarrow t_s = 2.3\tau \Rightarrow$ 3-4 bit
- $V_{out} = 99\%\ \Delta V \Rightarrow t_s = 4.6\tau \Rightarrow$ 6-7 bit
- $V_{out} = 99.9\%\ \Delta V \Rightarrow t_s = 7\tau \Rightarrow$ 9-10 bit



after fabrication