EECS240 – Spring 2010

Lecture 9: Amplifiers

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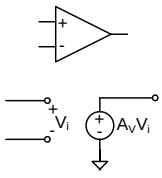
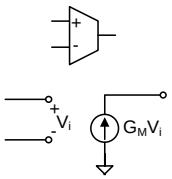
OpAmps and OTAs

OpAmp



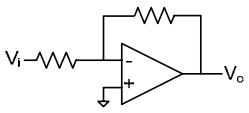
- High voltage gain, high input impedance
- Voltage source output (low impedance)

OTA

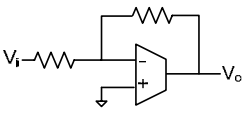


- High "voltage" gain, high input impedance
- Current source output (high impedance)

Resistive Feedback

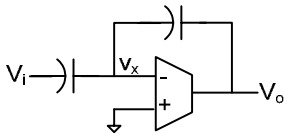


- Open-loop gain: ∞
- (Independent of R_f)



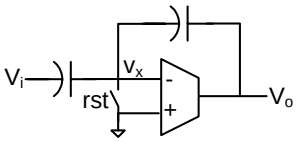
- Open-loop gain: G_mR_f
  - Feedback loads the OTA
- How about large R_f?
  - Lots of area, parasitic poles
- Need a different solution…

How about Capacitive Feedback?



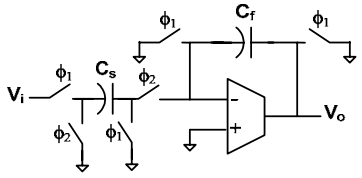
- At low frequency:
  - No loading from feedback network ($|Z_f| = \infty$)
- Gain drops at high frequency
  - But this happens in all amplifiers
- Does this really work?
  - Hint: what happens if you simulate this in SPICE?

Capacitive Feedback cont'd



- Charge on v_x is undefined – needs to be reset to known value
- Can we just do this once at start-up?
  - Depends how long you want to use the amplifier…
- Usually do this "reset" every cycle
  - Why each cycle instead of only once every N cycles?

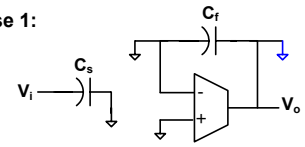
Switched-Capacitor Gain Stage



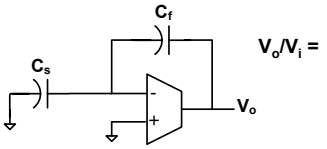
- Many possible topologies – one example shown here
- Clocks generally non-overlapping

SC Gain Stage Phases

- **Phase 1:**



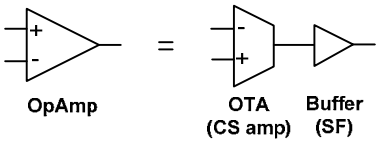
- **Phase 2:**



V_o/V_i =

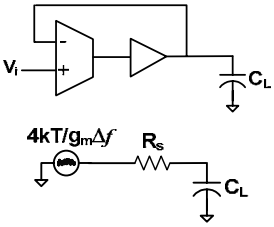
SC Gain Stage Waveforms

Opamp vs. OTA Revisited



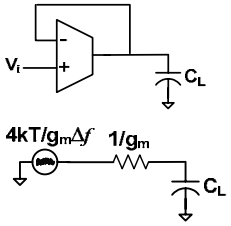
Opamp vs. OTA Noise

OpAmp



$$v_{o,n}^2 = \frac{4k_BT}{g_m}\frac{1}{4R_sC_L} = \frac{k_BT}{C_L}\frac{R_n}{R_s}$$

OTA



$$v_{o,n}^2 = \frac{k_BT}{C_L}$$

SC Gain Stage Noise