OpAmps and OTAs

OpAmp

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

O TA

- High “voltage” gain, high input impedance
- Current source output (high impedance)
Resistive Feedback

- Open-loop gain: $\infty$
- (Independent of $R_f$)
- Open-loop gain: $G_m R_f$
- 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:

  \[ V_i \quad C_s \quad V_o \]

- Phase 2:

  \[ V_o/V_i = \]

**SC Gain Stage Waveforms**
Opamp vs. OTA Revisited

\[ \text{OpAmp} \quad = \quad \text{OTA (CS amp)} \quad \text{Buffer (SF)} \]

Opamp vs. OTA Noise

\[ V_{o,n}^2 = \frac{4kT}{g_m \Delta f} \quad \frac{1}{4R_C L} = \frac{kT}{g_m} \frac{R_n}{C_L R_s} \]

\[ V_{o,n}^2 = \frac{kT}{C_L} \]

SC Gain Stage Noise