Problem with Common-Mode

- What if $I_L < I_{tail}/2$?
  - Will capacitive feedback solve this?
- Typical solution: Common-mode feedback
  - Sense CM at output
  - Adjust some knob to alter CM

Common-Mode Sensing

- Simplest CM sensor: pair of resistors
- Resistors load the OTA (reduce gain)
  - If make $R$ large, get slow $V_{CM}$ tracking
  - Is this a problem?

Capacitive Sensing

- Capacitive sensing avoids DC loading
  - (still creates AC load though)
  - Needs to be reset to remove initial offset
    - Just like capacitive feedback

Sensing Scheme #2

- Isolated CM sensing
  - Works reasonably well
  - But hard to use with wide swing amplifier output

Adjusting Common-Mode

- Really only two knobs:
  - Knob A: adjust load current
  - Knob B: adjust tail current
Example Common-Mode Feedback

- Secondary amplifier enforces $V_{cm} = V_{cm_{ref}}$
- Place dominant pole at $V_{bip}$, or $V_{cm}$?

CMRR Fix

- What if two PMOS transistors aren't perfectly matched?

Capacitive CMFB

- How to choose $C_{cm}$?
  - "Small": CM loop gain low
  - "Large": Loading on diff. output high