

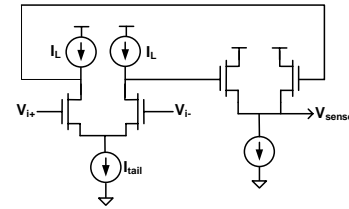
## EECS240 – Spring 2010

### Lecture 15: Common-Mode Feedback



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## Sensing Scheme #2



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

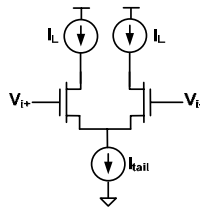
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## Problem with Common-Mode

- 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

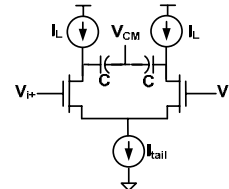


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## Capacitive Sensing



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

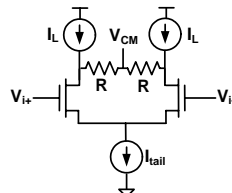
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## Common-Mode Sensing

- **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?



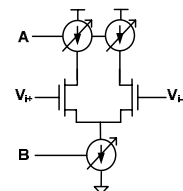
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## Adjusting Common-Mode

- **Really only two knobs:**
- **Knob A: adjust load current**
- **Knob B: adjust tail current**

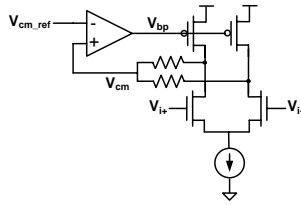


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## Example Common-Mode Feedback



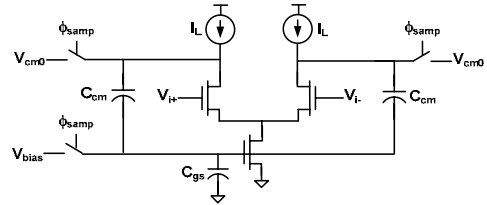
- Secondary amplifier enforces  $V_{cm} = V_{cm\_ref}$
- Place dominant pole at  $V_{bp}$ , or  $V_{cm}$ ?

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## Initialization

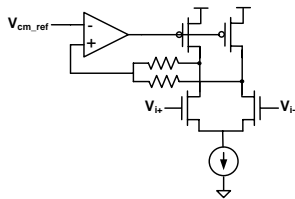


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## CMRR Fix



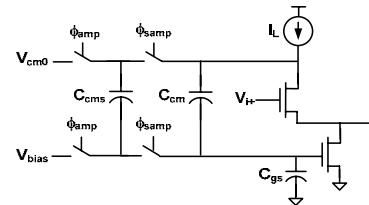
- What if two PMOS transistors aren't perfectly matched?

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## "Continuous" CMFB

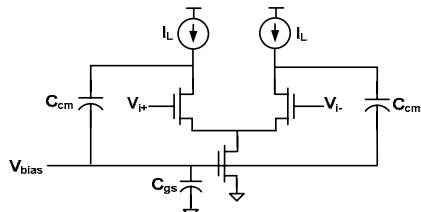


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## Capacitive CMFB



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

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