EE 240B – Spring 2018

Advanced Analog Integrated Circuits

Lecture 8: Operational Transconductance Amplifiers (II)

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Closer Look at Cascode Dynamics

Aside: Useful TF Properties

Cascode Z_{out} vs. f

Pole-Zero Doublets

Discussion

- **Doublet generally not important in "simple" cascode since it shows up at high frequencies**
- **But, doublets can show up in similar circuits**
  - In particular, when you try and increase the gain beyond what a simple cascode can support

Gain Boosting

- **Use feedback to further increase R_{out}**
  - No increase of V_{min} (unlike double cascode)
- **References:**
  - B. J. Hosticka, "Improvement of the gain of MOS amplifiers," JSSC, Dec. 1979 , pp. 1111-4.
  - E. Sackinger and W. Guggenbuhl, "A high-swing high-impedance MOS cascode circuit", JSSC, Feb. 1990, pp. 289-298.
  - K. Bult, G. Geelen, "A fast-settling CMOS op-amp for SC circuits with 90-dB DC gain," JSSC, Dec. 1990 , pp. 1379-84.

Stability?

Gain-Boosted Z_{out}

If it works, do it again!

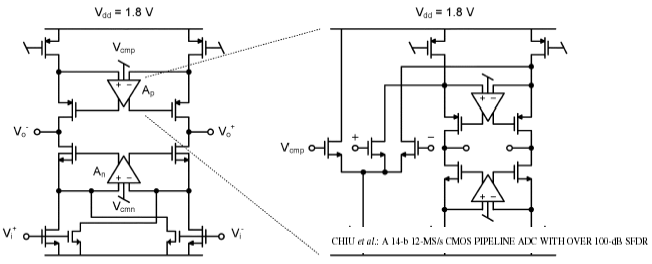
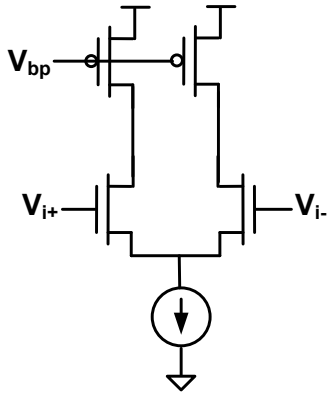


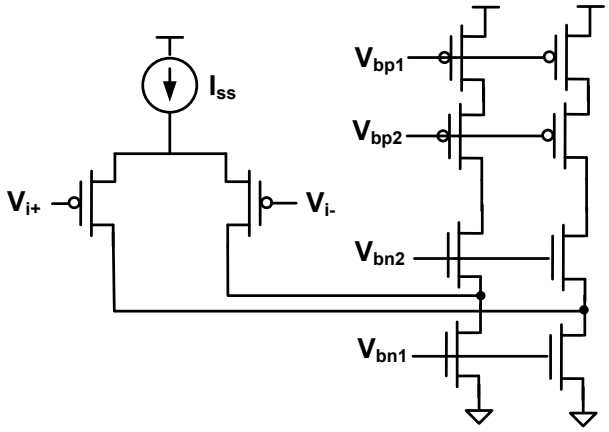
Fig. 8. Nested CMOS gain-boosting technique.

- **Since in advanced scaled CMOS $g_m r_o$ is small, we can use nested gain boosting for higher output impedance.**
- **Watch out for pole-zero doublets!**

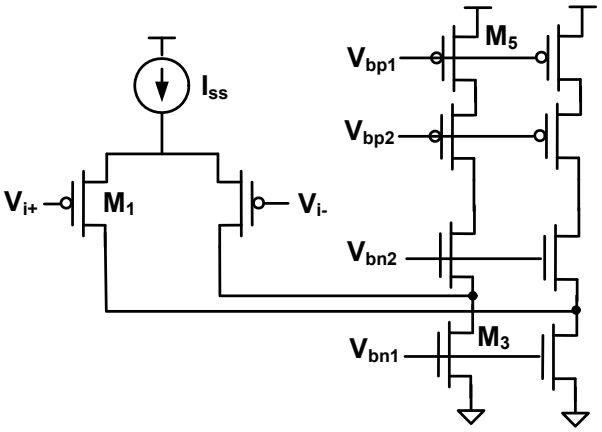
Telescopic OTA: Common Mode vs. Swing



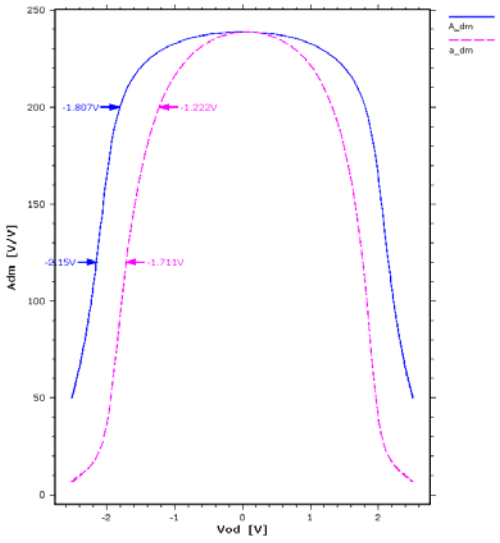
Folded-Cascode Schematic



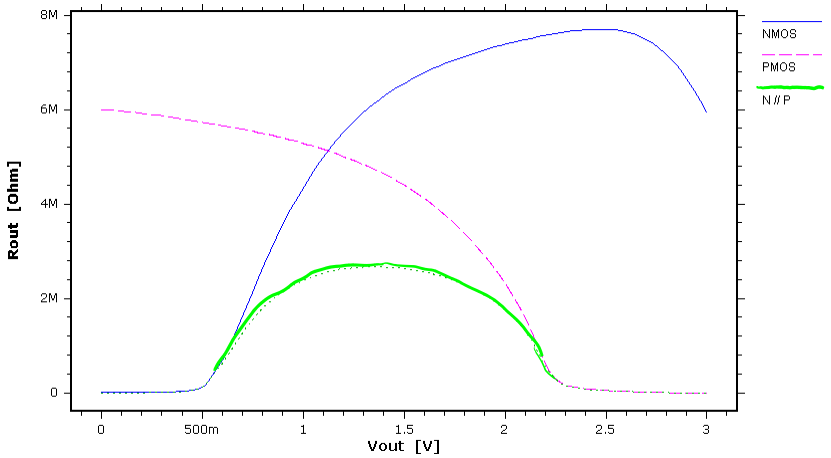
Folded-Cascode Noise



Low Frequency Gain: a_v and A_v

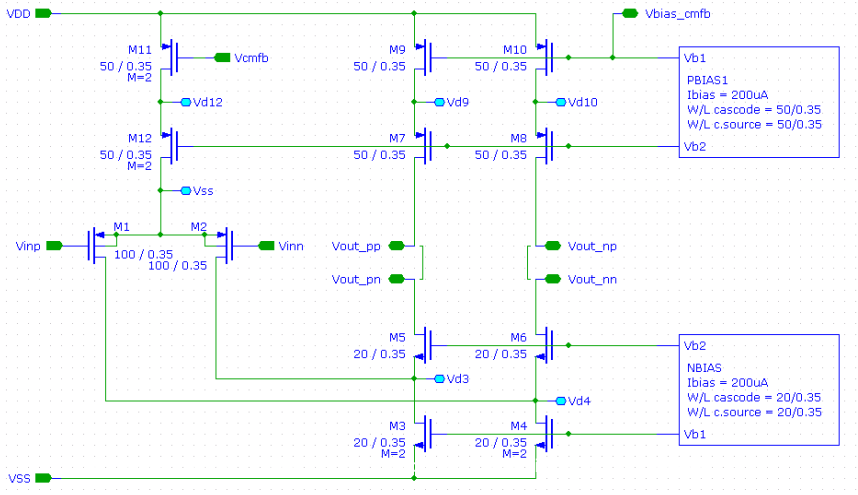


Output Resistance

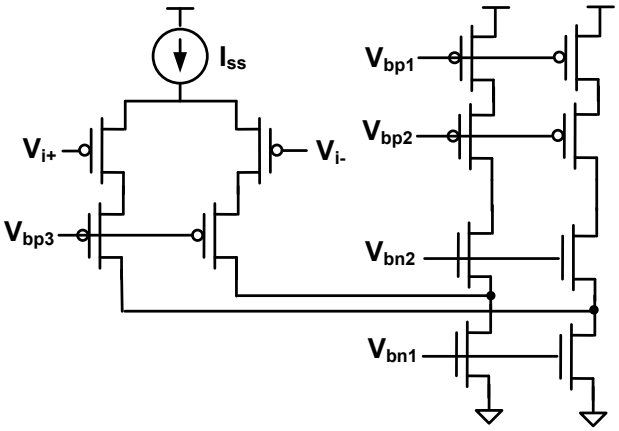


Beware of r_o imbalance between NMOS and PMOS current sources

Simulation Schematic



Input Cascode



Reminder: Cascode Zin

Biasing and Parasitic Feedback