Closer Look at Cascode Dynamics
Aside: Useful TF Properties

Cascode $Z_{out} \text{ vs. } f$
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 $R_{\text{out}}$
  • No increase of $V_{\text{min}}$ (unlike double cascode)

• References:

Stability?
**Gain-Boosted Z\textsubscript{out}**

If it works, do it again!

- 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

Many more transistors, but overall characteristics very similar to common-source stage.