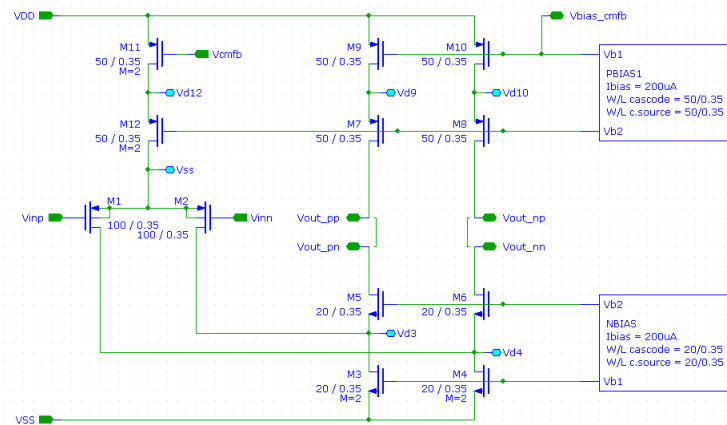


Folded Cascode

- Good general purpose OTA
- Analysis
 - Bias
 - Gain
 - Input capacitance
 - Frequency response
 - Feedback, stability
 - Settling time
 - Noise
 - Common-Mode Feedback
- Design
 - Specifications
 - Circuit parameters



Schematic



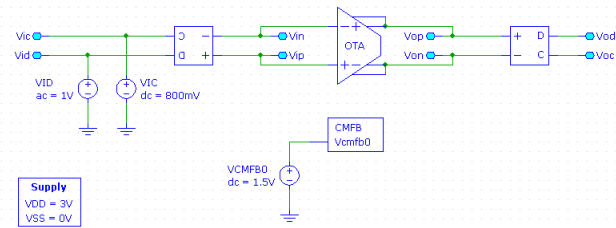
DC Gain, Bias

Folded Cascode: Open-Loop Gain

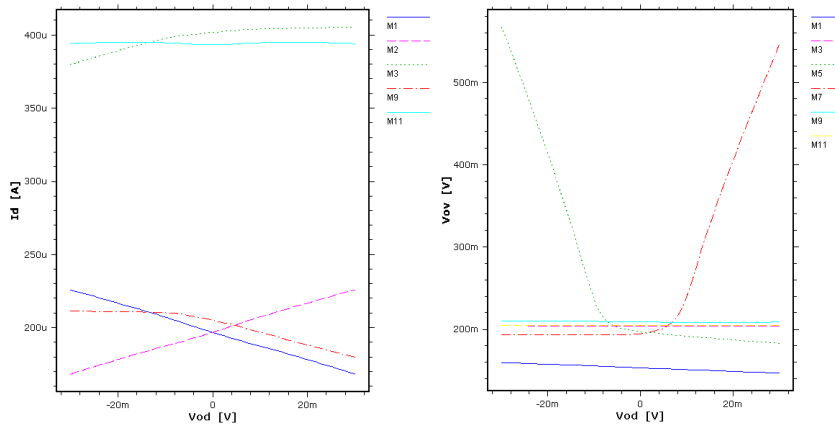
ISS = 400uA
 (W/L)₁ = 100/0.35
 (W/L)₃ = 20/0.35
 (W/L)₅ = 20/0.35
 (W/L)₇ = 50/0.35
 (W/L)₉ = 50/0.35

DC Analysis DC_Adm
 Device VID
 sweep from -50m to 50m (100 steps)

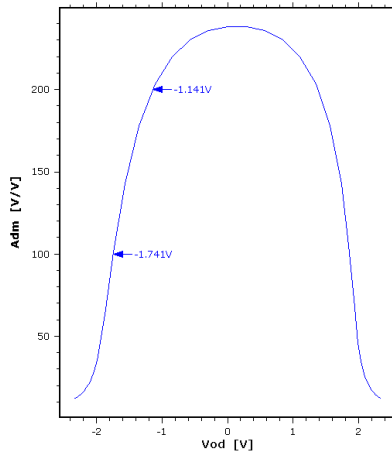
DC Analysis DC_Acm
 Device VIC
 sweep from 0 to 3 (30 steps)



Bias ... Differential Inputs



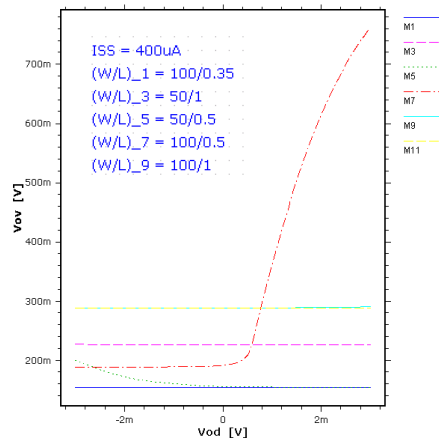
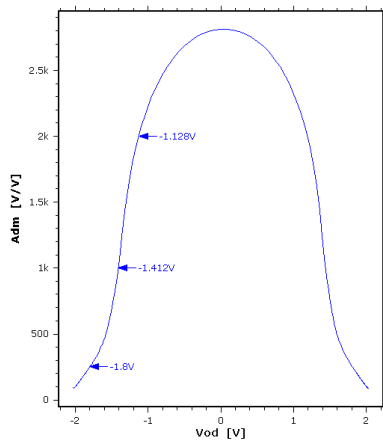
Low Frequency Gain, A_{dm}



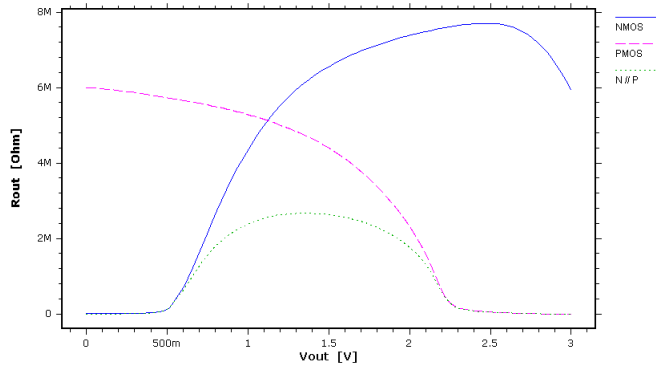
- Gain / Output Range tradeoff
- Increasing A_{dm} :
 - Moderate:
 - Increase L
 - Affects V_{ov} , phase margin
 - Substantial:
 - Double Cascode
 - Gain boosting
 - Multi-stage cascode



Increased A_{dm}



Output Resistance



Beware of imbalance between NMOS and PMOS current source



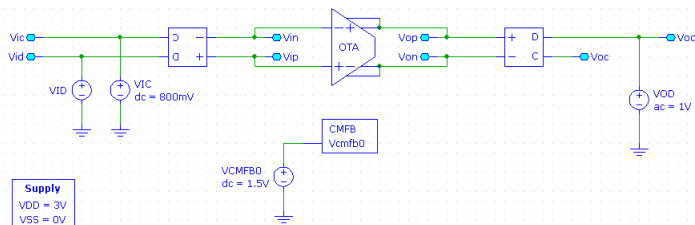
Gm, Cod Test Circuit

Folded Cascode: Gm

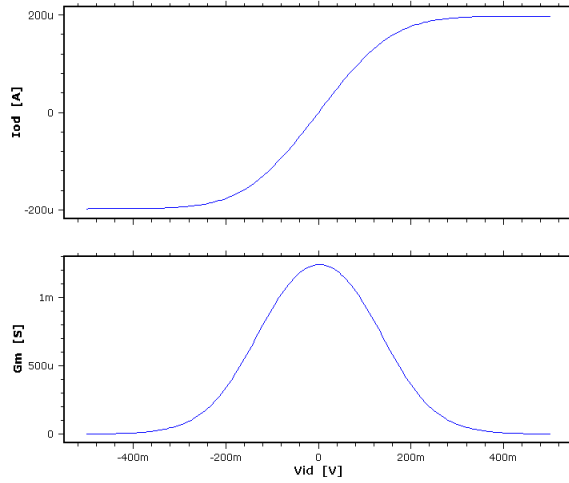
ISS = 400uA
 (W/L)₁ = 100/0.35
 (W/L)₃ = 50/1
 (W/L)₅ = 50/0.5
 (W/L)₇ = 100/0.5
 (W/L)₉ = 100/1

DC Analysis DC
 Device VID
 sweep from -500m to 500m (200 steps)

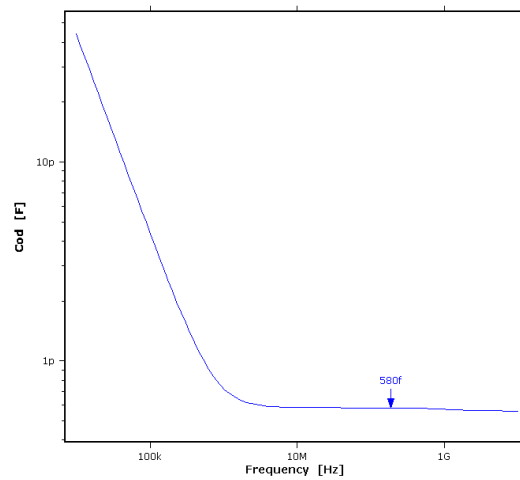
AC Analysis AC1
 log sweep from 10k to 10G (101 steps)



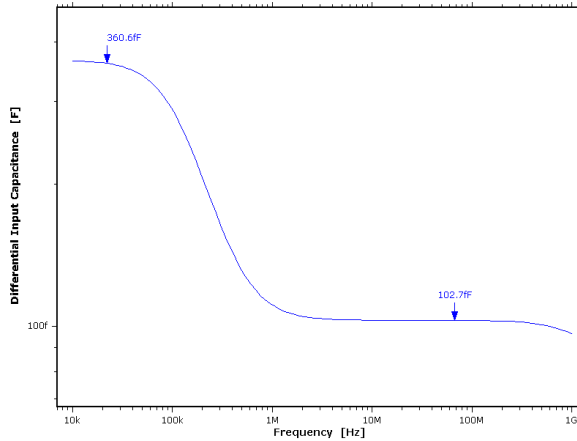
Transconductance



Differential Output Capacitance



Differential Input Capacitance



$$C_{GS1} = \frac{2}{3} C_{ox} W L = 117 \text{ fF}$$

Miller effect significantly increases C_{id} at low frequency

Cascoding M1, M2 helps (at the expense of reduced input common-mode range)



Frequency Response (A_{dm})

