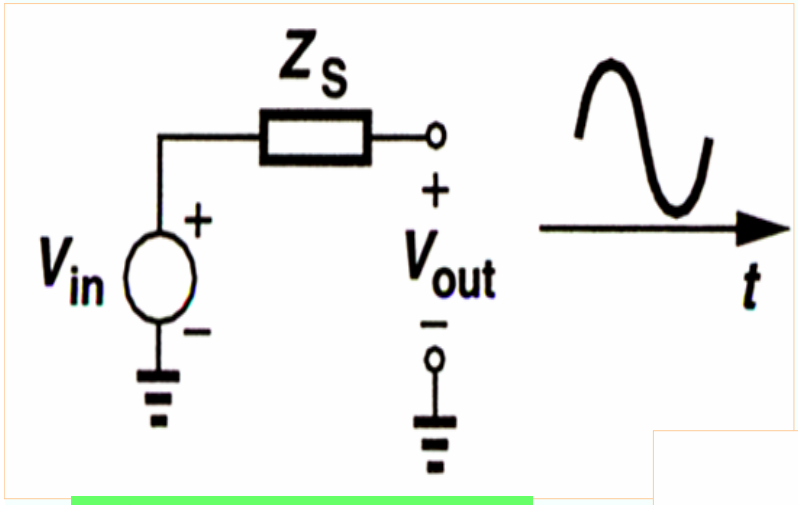
CH5 Differential amplifier

5.0 differential signal

5.1 R-load differential amplifier

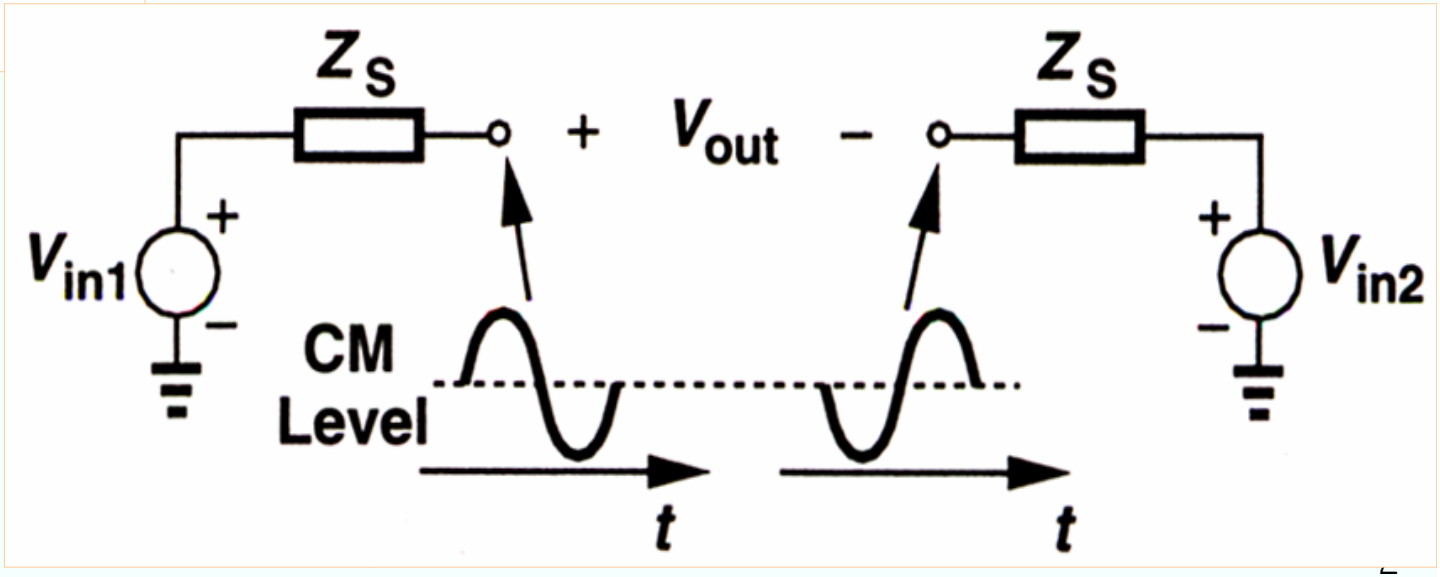
5.2 Active load differential amplifier

Differential Signal versus Single Ended Signal



Single ended

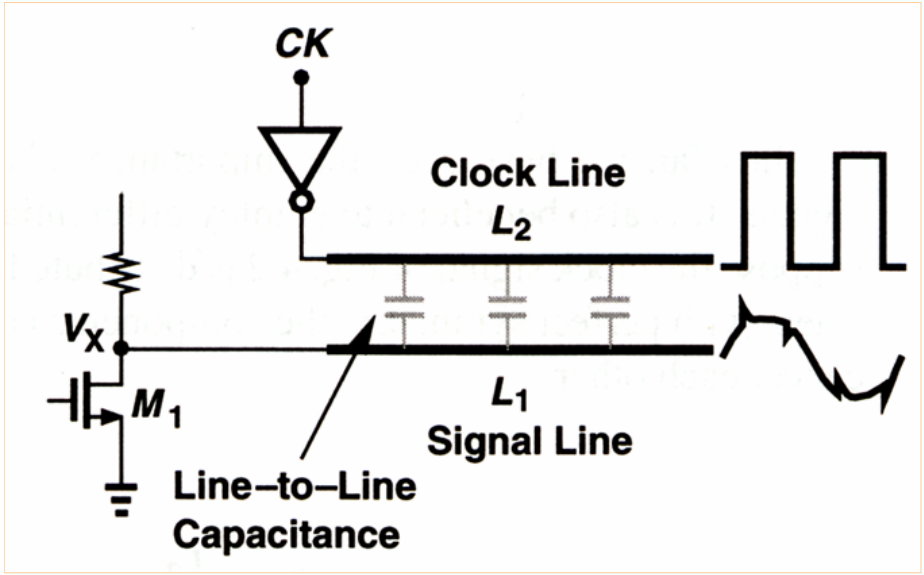
Differential



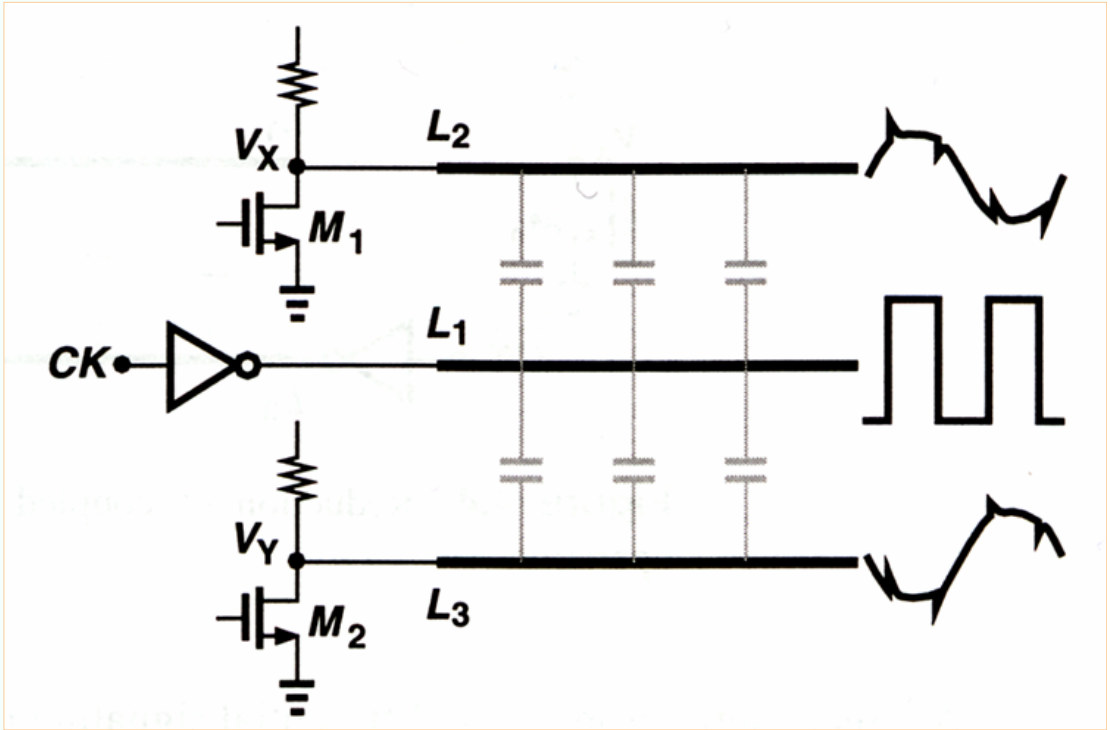
Differential Signal

Highly immune to environmental noise (1) Digital noise

environmental noise => common mode => rejected by diff amp



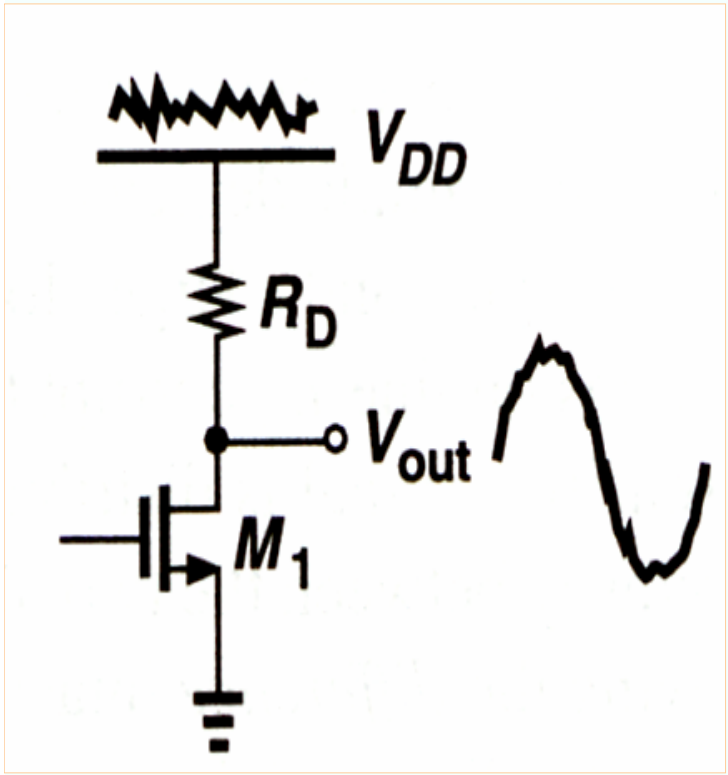
Single ended



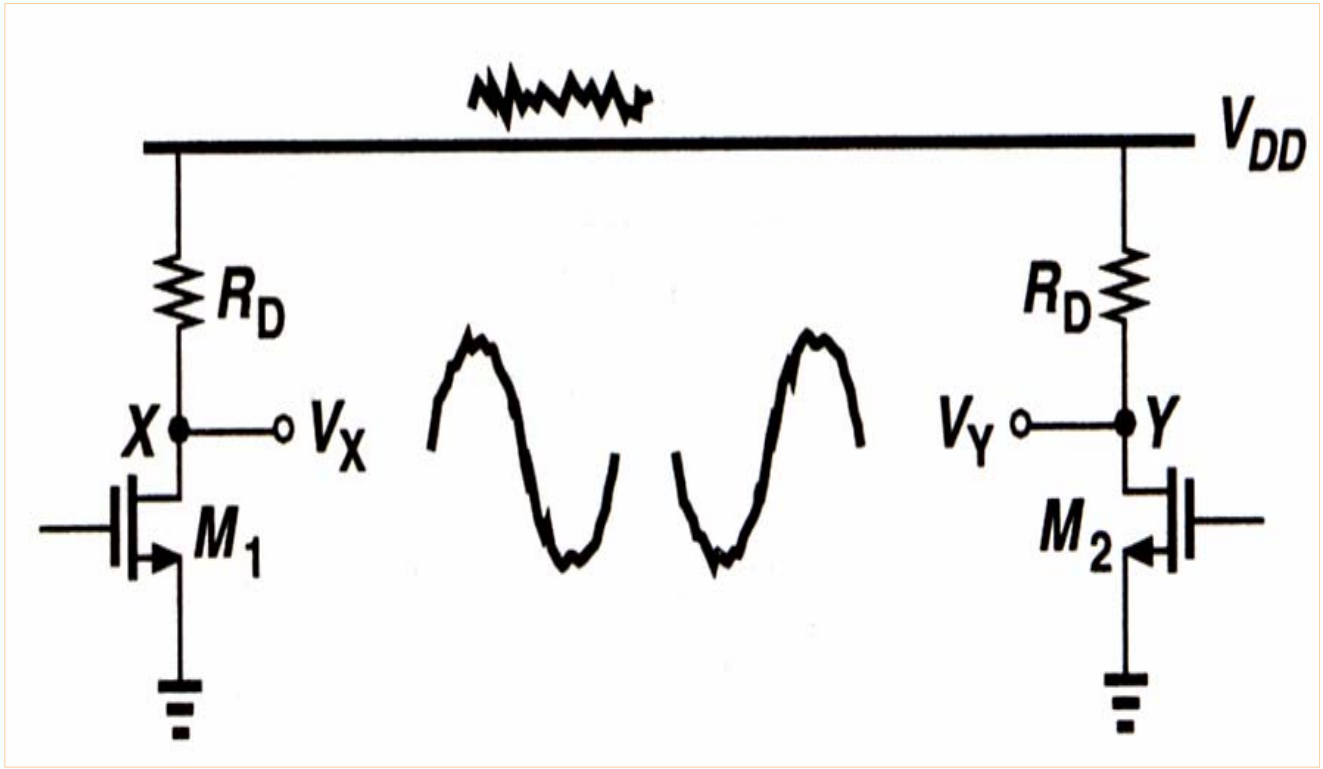
Differential

Differential Signal

Highly immune to environmental noise (2) Supply noise

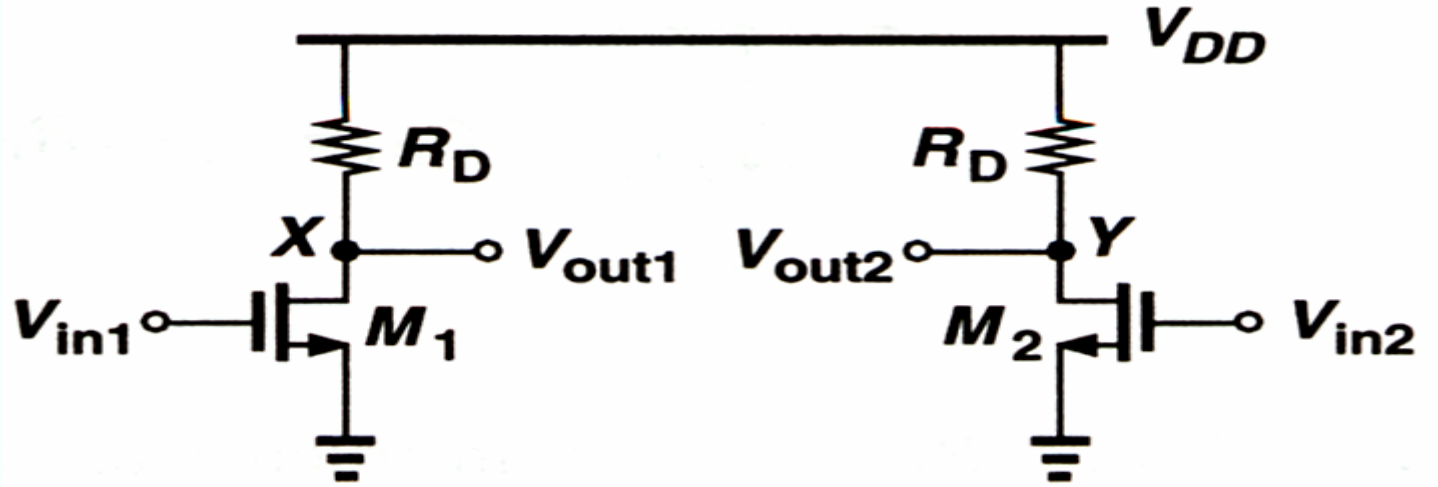


Single ended



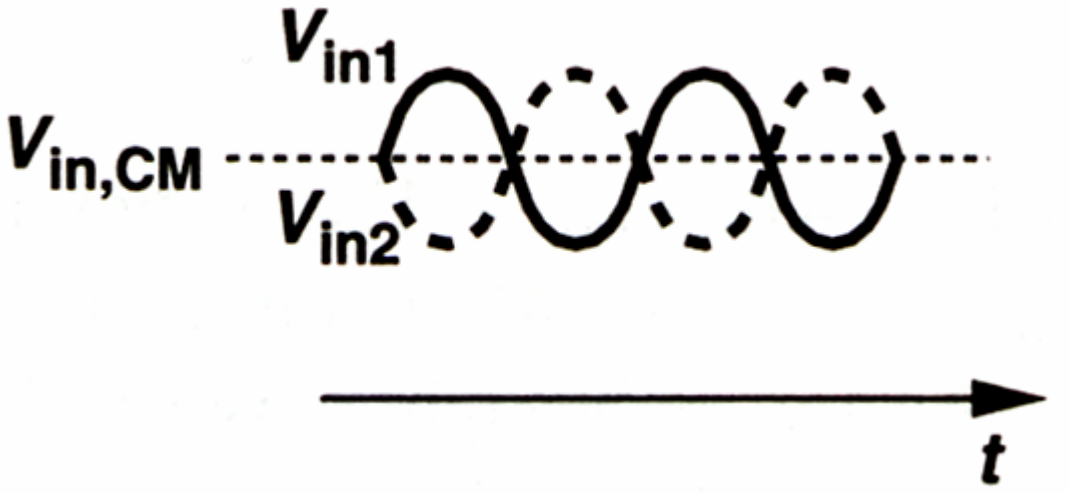
Differential

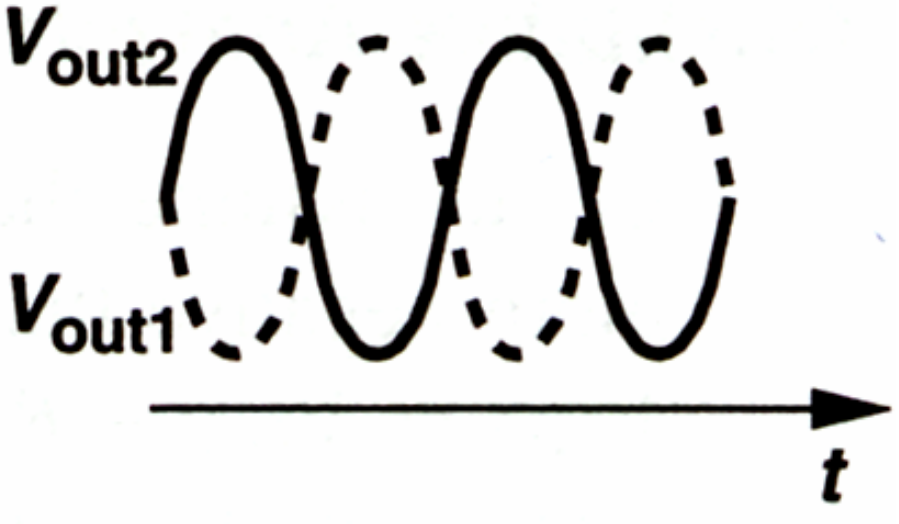
Simple differential pair



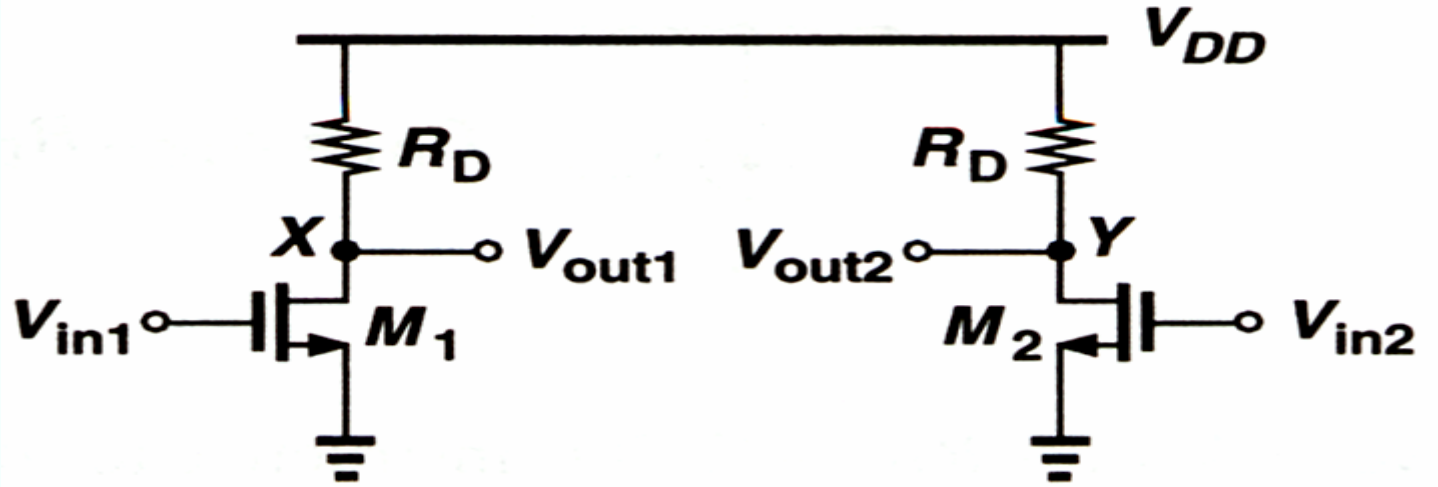
Advantage

High rejection of environmental noise (digital & supply noise)



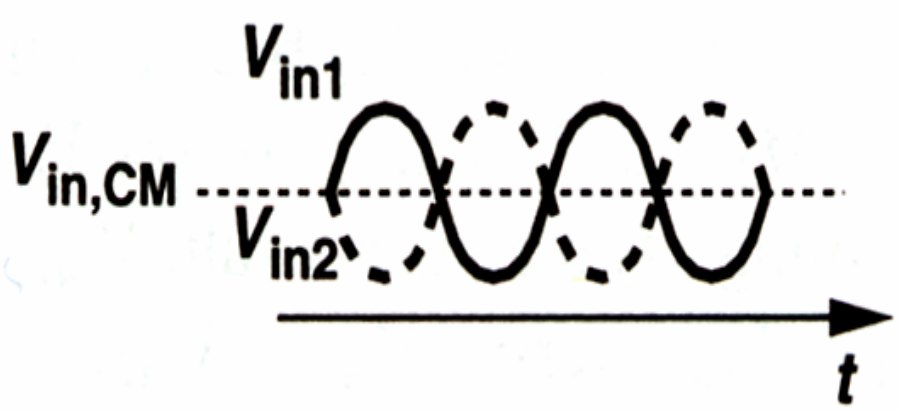


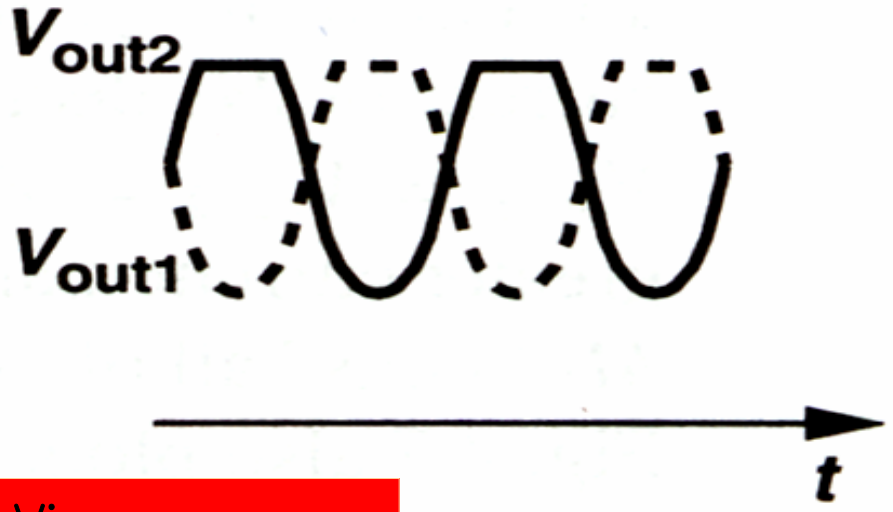
Simple differential pair



Disadvantage

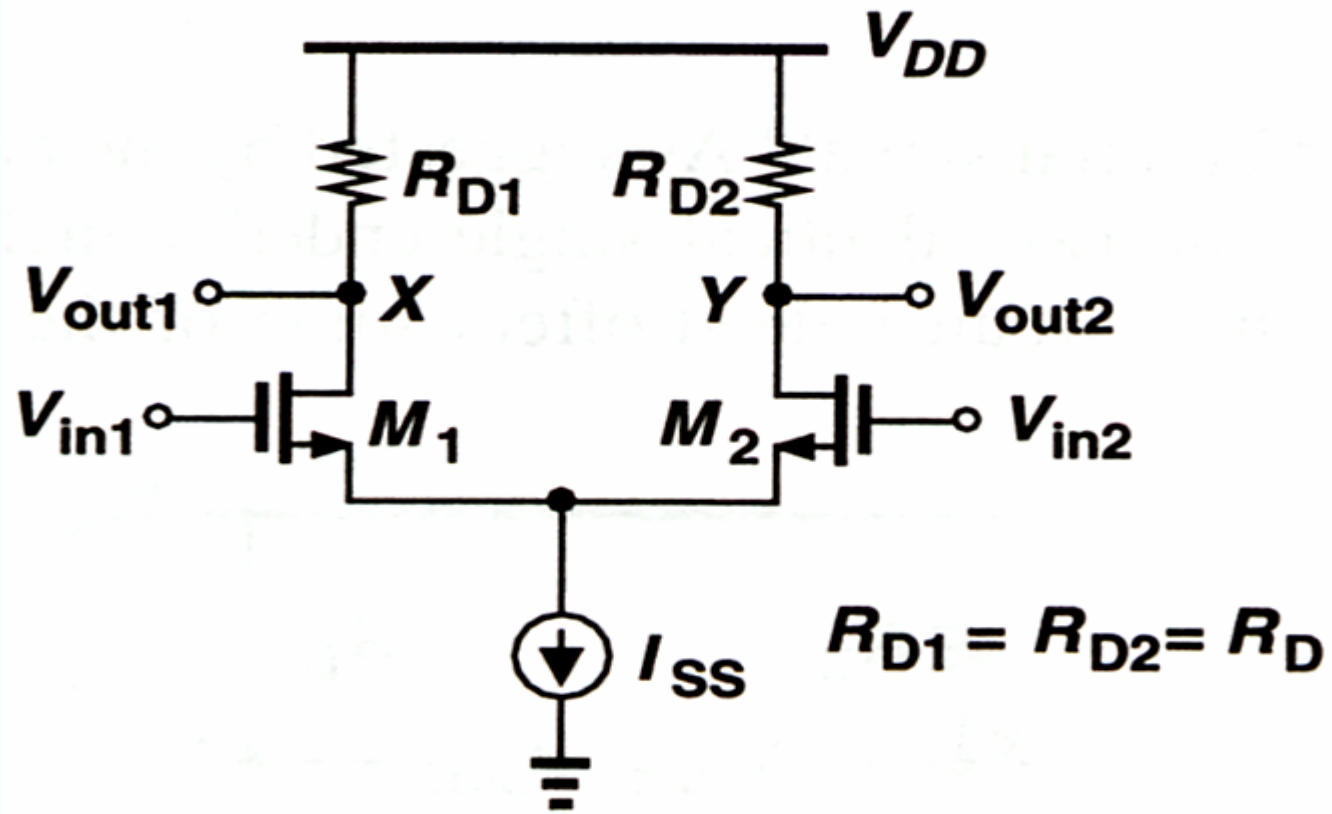
Change in input common mode level(Vin.cm) => change in bias I, gm or clipping





Vout.cm: sensitive to Vin.cm

Differential pair with tail current source

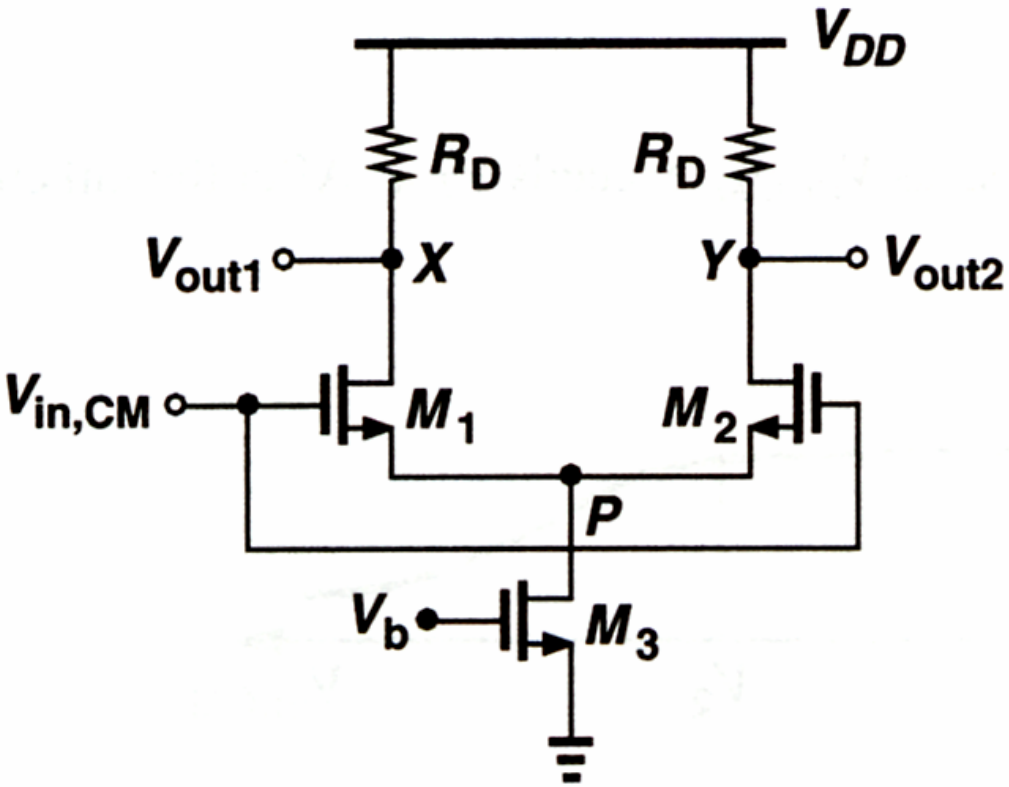


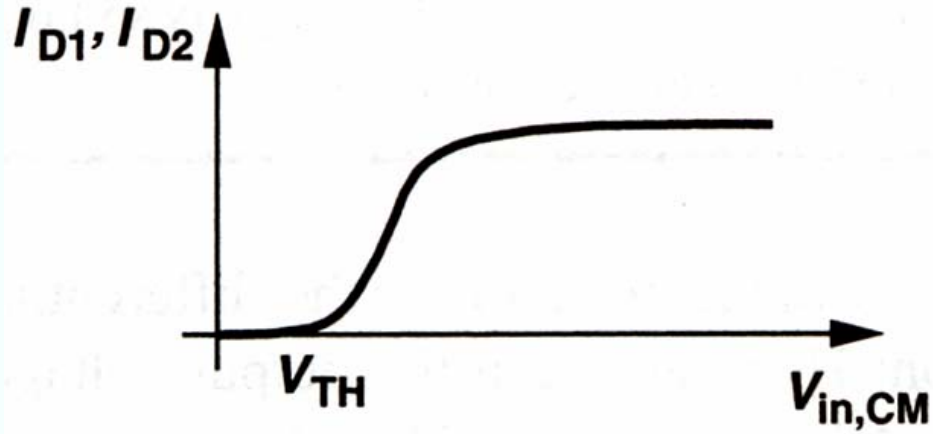
Vout.cm = VDD – 0.5 x ISS x RD : independent of Vin.cm

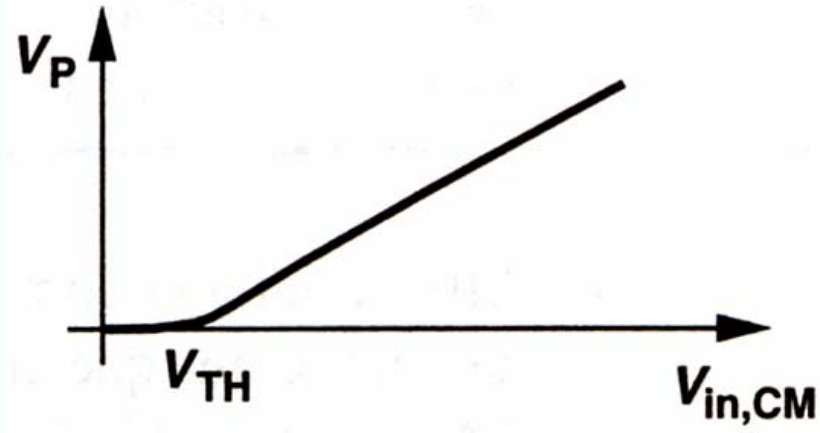
(Vout.max = VDD, Vout.min = VDD – ISS x RD : both independent of Vin.cm)

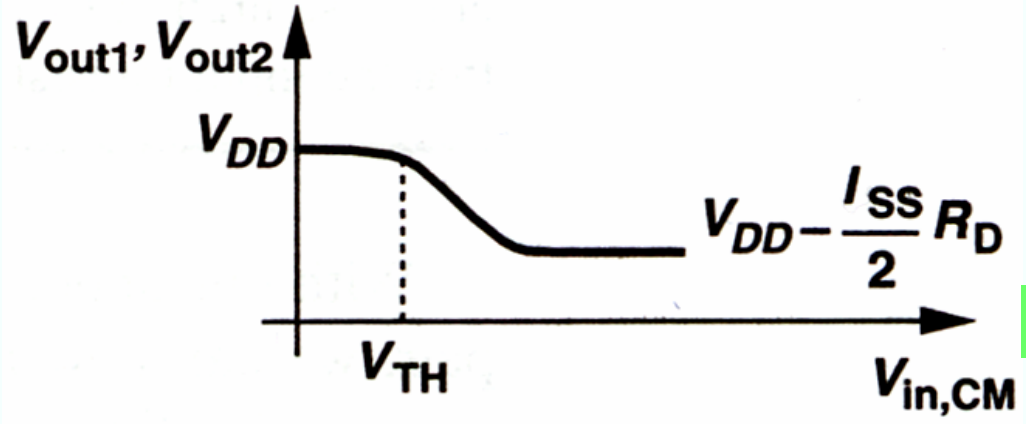
Small-signal common mode gain Avc = 0

Differential pair with tail current source







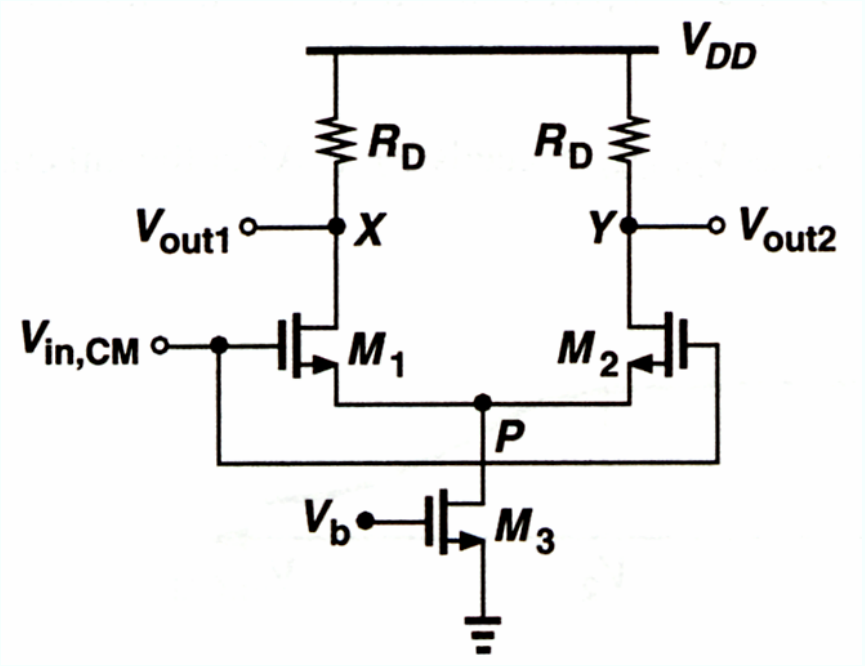


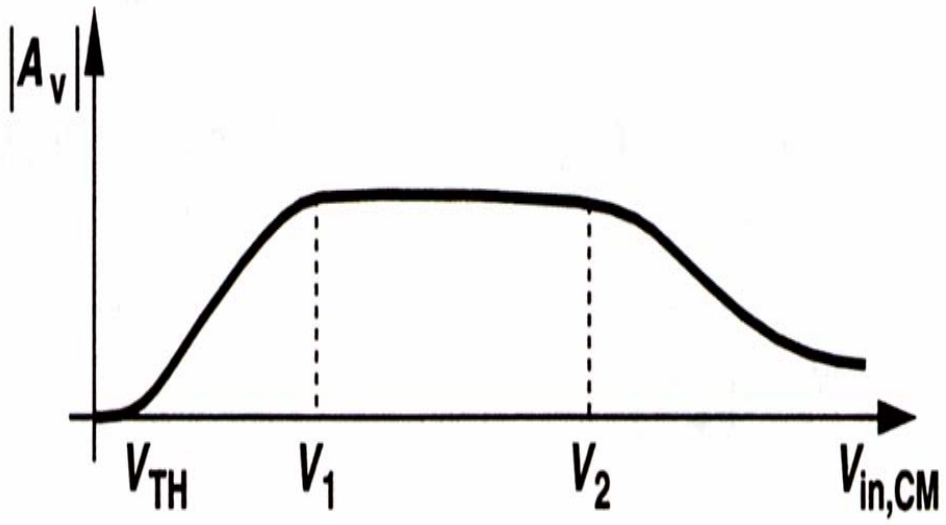
Active input CM V range

Active input common mode range:

range of Vin.cm with all MOS in saturation ➔ High Avd

$$V_{GS1} + (V_{GS3} - V_{TH3}) \le V_{in,CM} \le \min\left[V_{DD} - R_D\frac{I_{SS}}{2} + V_{TH},\ V_{DD}\right]$$





Small-signal diff mode voltage gain