# EE539: Analog Integrated Circuit Design

Nagendra Krishnapura (nagendra@iitm.ac.in)

28/3/06

## NOISE ANALYSIS OF TELESCOPIC CASCODE.

| TRANSISTOR | NOISE CURRENT CONTRIBUTED TO OUTPUT |
|---|---|
| $M_0$ | 0 |
| $M_1$ | $i_1$ |
| $M_2$ | $i_2$ |
| $M_3$ | $i_3$ |
| $M_4$ | $i_4$ |
| $M_5$ | 0 |
| $M_6$ | 0 |
| $M_7$ | 0 |
| $M_8$ | 0 |

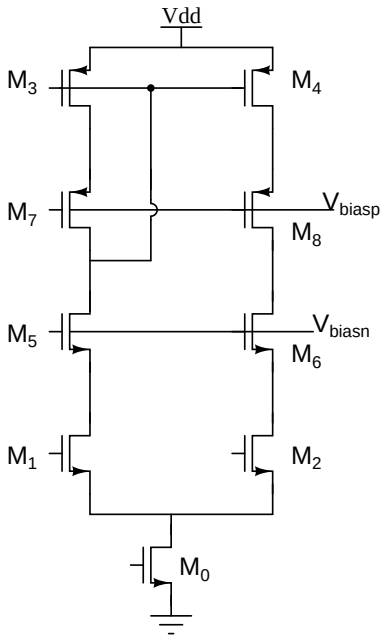


Figure 1: TELESCOPIC CASCODE

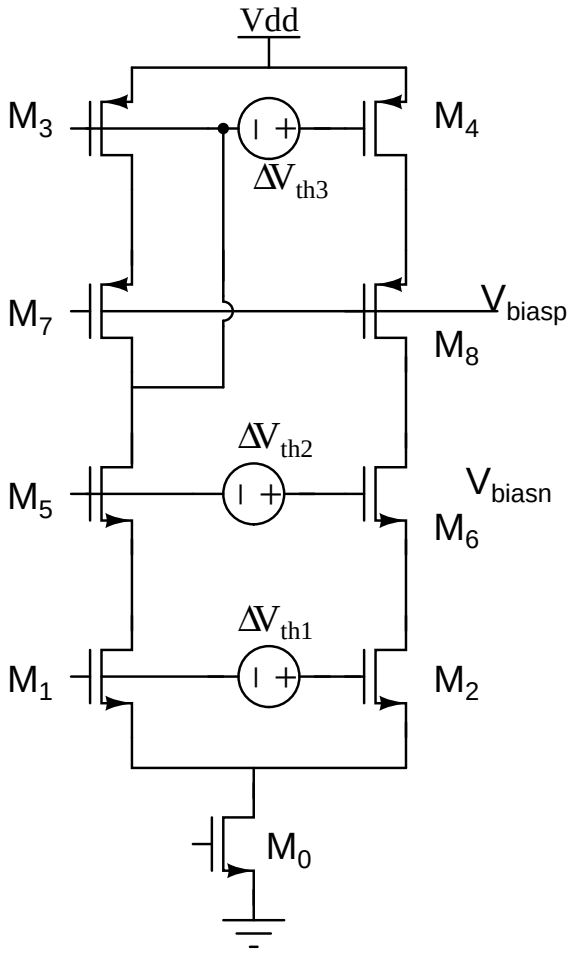


Figure 2: TELESCOPIC CASCODE

## EFFECT OF Vth MISMATCH

If $g_{ds}$ is neglected,there is no effect for $\Delta V_{th2}$

| TRANSISTOR | NOISE CURRENT CONTRIBUTED TO OUTPUT |
|---|---|
| $M_0$ | 0 |
| $M_1$ and $M_2$ | $g_{m1}\Delta V_{th1}$ |
| $M_3$ and $M_4$ | $g_{m3}\Delta V_{th3}$ |
| $M_5$ and $M_6$ | 0 |
| $M_7$ and $M_8$ | 0 |

$$\sigma_{os,in} = \sqrt{{\sigma_{V_{th1}}}^2 + {\sigma_{V_{th3}}}^2 \frac{{g_{m3}}^2}{{g_{m1}}^2}}$$

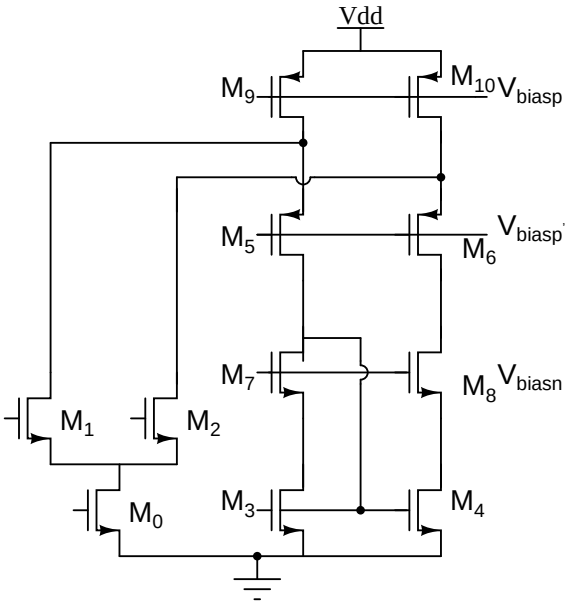


Figure 3: FOLDED CASCODE

## NOISE ANALYSIS OF FOLDED CASCODE.

| TRANSISTOR | NOISE CURRENT CONTRIBUTED TO OUTPUT |
|---|---|
| $M_0$ | 0 |
| $M_1$ | $i_1$ |
| $M_2$ | $i_2$ |
| $M_3$ | $i_3$ |
| $M_4$ | $i_4$ |
| $M_5$ | 0 |
| $M_6$ | 0 |
| $M_7$ | 0 |
| $M_8$ | 0 |
| $M_9$ | $i_9$ |
| $M_10$ | $i_{10}$ |

$$S_{out} = \frac{16kT}{3}(g_{m1} + g_{m3} + g_{m9}) \quad (1)$$

$$S_{in} = \frac{S_{out}}{g_{m1}^2} \quad (2)$$

$$S_{in} = \frac{16kT}{3g_{m1}}(1 + \frac{g_{m3}}{g_{m1}} + \frac{g_{m9}}{g_{m1}}) \quad (3)$$

so folded cascode has more noise compared to telescopic cascode.