Two-stage Fully-differential Opamp

* \( V_{cm1} \) \text{ control gates of } M_o \text{ or } M_s/M_y \\
* \( V_{cm2} \) \text{ control gates of } M_s/M_o \\
  \text{ or gates of } M_s/M_y \\
  \text{ or gate of } M_o \\
M_s/M_y \text{ - pseudo diff. pairs} \\
4 \text{ have CM gain}
\[ V_{cm1_{\text{ref}}} = V_{DD} - V_{SA5} / 2 \]

\[ V_{cm2_{\text{ref}}} = V_{DD} / 2 \] for max swing

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Separate CMFB

Stage 1

* Control gates of \( M_{by} \)
* Set \( (V_{OP1} + V_{OM1}) / 2 = V_{DD} - V_{SA5} / 2 \)

\[ = V_{cm1_{\text{ref}}} \]

* Use CM detector which is non-resistive
Stage 2

* $V_{cm,ref} = V_{DD}/2$

* resistive CM detector

Common

* Compensation

* $V_{ic}$ 1-stage opamp in CMFB ideal

* $OTA_1$ - nmos input pair w/ pmos load

* $OTA_2$ - pmos input pair w/ nmos load

Single f.b. loop

![Diagram of a single feedback loop circuit with labeled components and connections](image-url)
Single f,b, loop

* 3 stages in feedback, lots of gain \Rightarrow\text{harder to stabilise}
* Reduce OTA gain
  - use diode connected loads
* $C_c$ - can be designed to stabilise CMFB loop as well.