Low-Voltage Circuits in Floating-Gate and Double-Gate CMOS

Bradley A. Minch

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Mixed Analog-Digital VLSI Circuits and Systems Lab

- **Research focus**: Low-voltage/low-power analog and mixed-signal circuit design
- **Current M.S./Ph.D. students**:
  Sunitha Bandla, Abhishek Kammula, Eric McDonald, Kofi Odame, Sheng-Yu Peng
- **Former M.S./Ph.D. students**:
  Karan Mathur, Mark Neidengard, Yuan Yang
- **Current projects**:
  - High-level synthesis of translinear and log-domain circuits and systems
  - Floating-gate MOS (FGMOS) circuit design
  - Double-gate MOS (DGMOS) modelling and circuit design
  - Chemical sensing with chemoreceiptive neuron MOS (CνMOS) transistors

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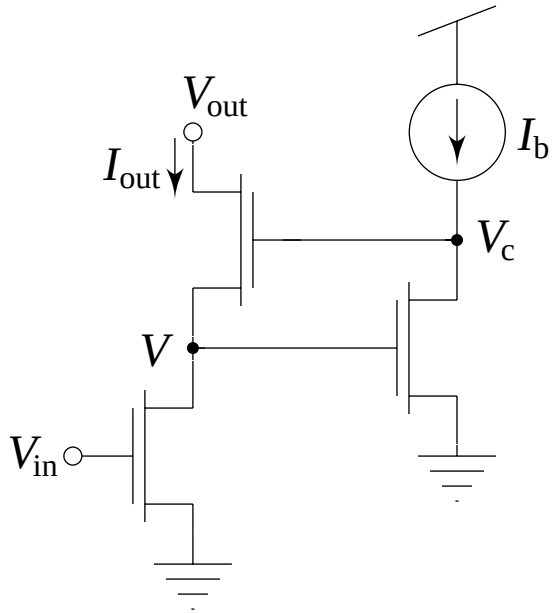
In Search of Low-Voltage Topologies: Regulated Cascode

- Säckinger's regulated cascode circuit has a very high incremental R_{out}.



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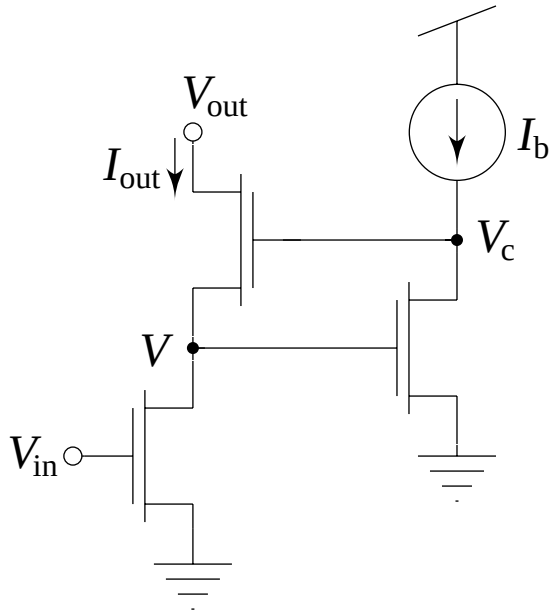

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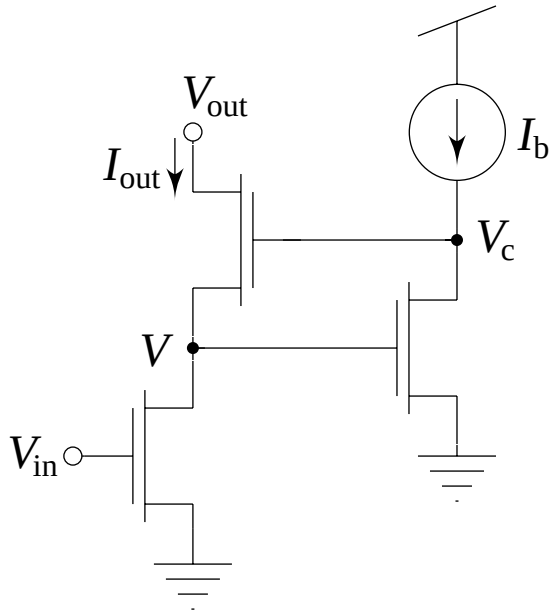

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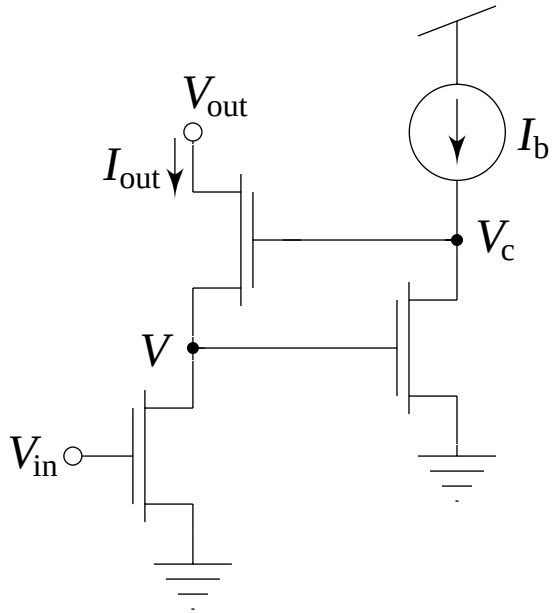

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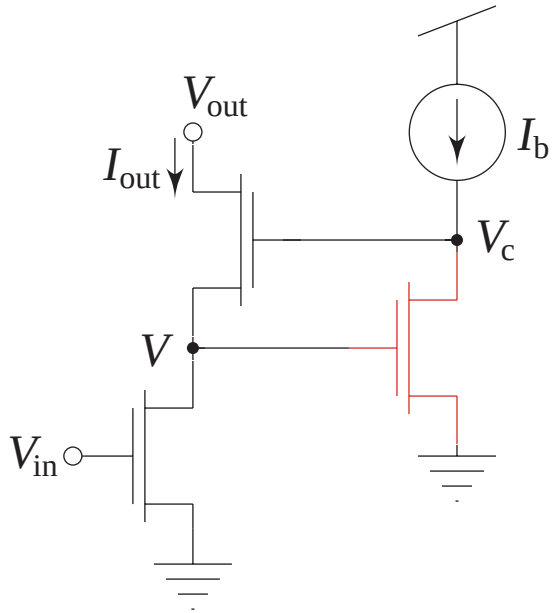

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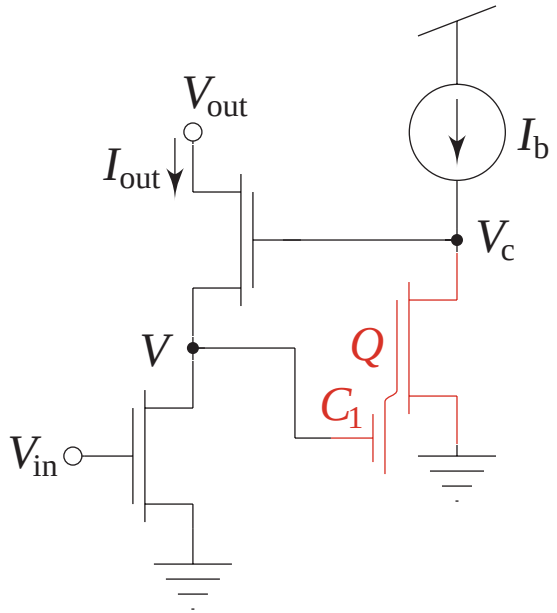
- Suppose we make the common-source transistor a FGMOS transistor.



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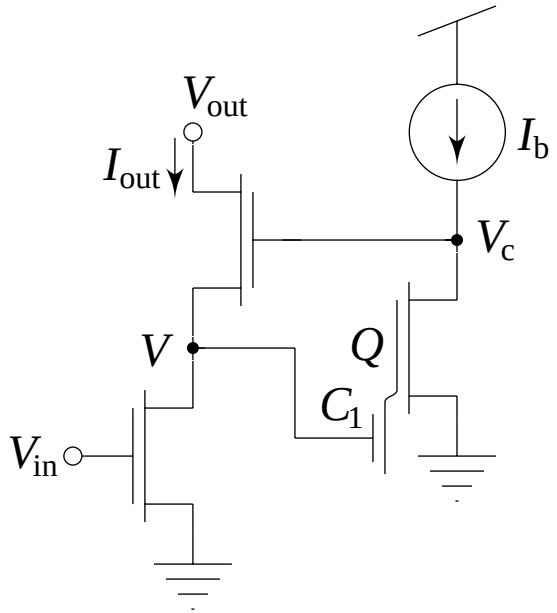

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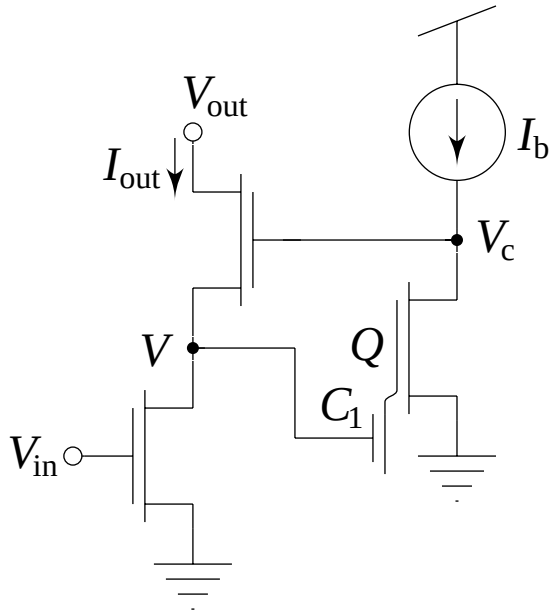

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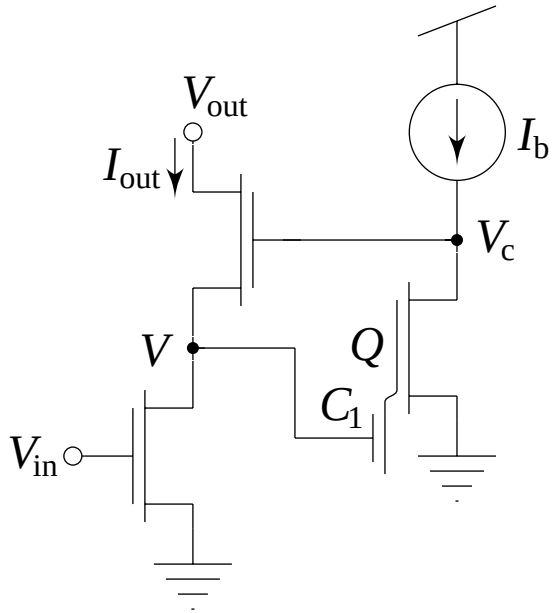
- Not robust to drift in Q, or changes in I_b or temperature.



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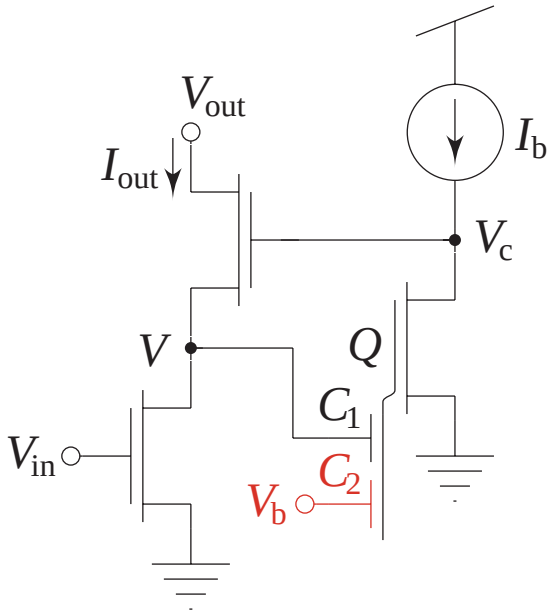
- We can add a second control gate and make $V \approx V_{\mathrm{DSsat}}$ by adjusting V_{b} rather than Q.



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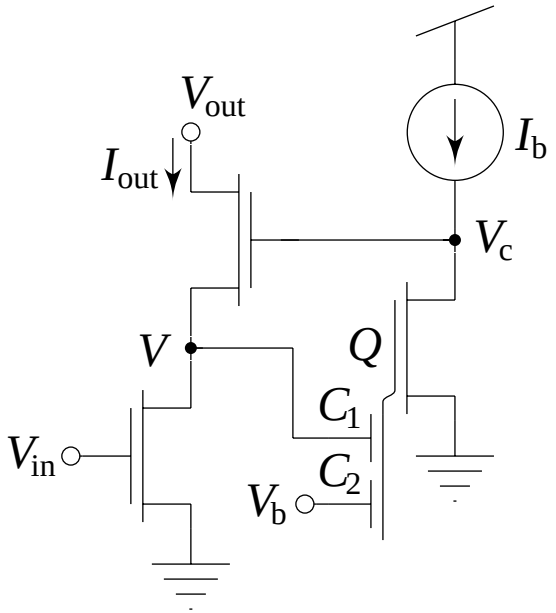
- We can add a second control gate and make $V \approx V_{DSsat}$ by adjusting V_b rather than Q.
- How can we set V_b to make $V \approx V_{DSsat}$?



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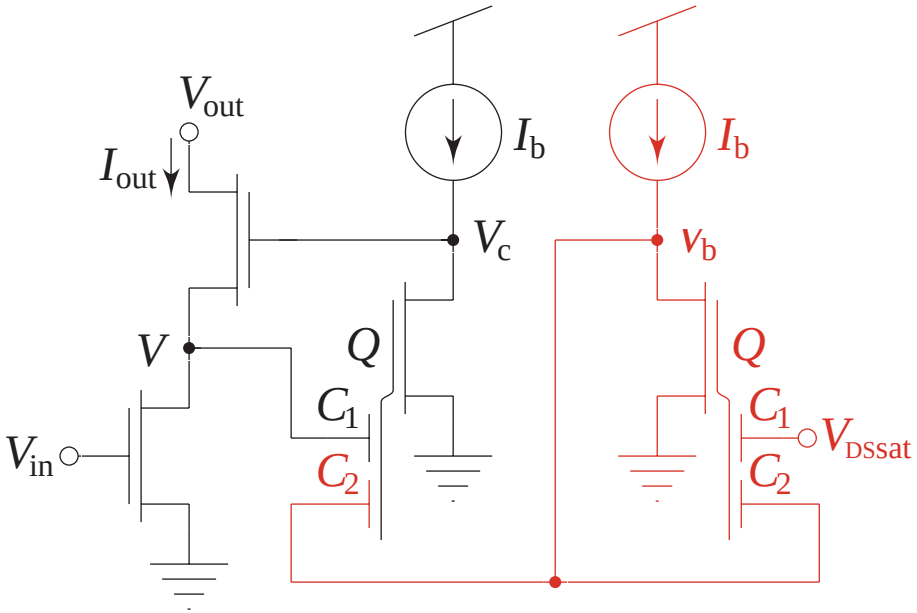

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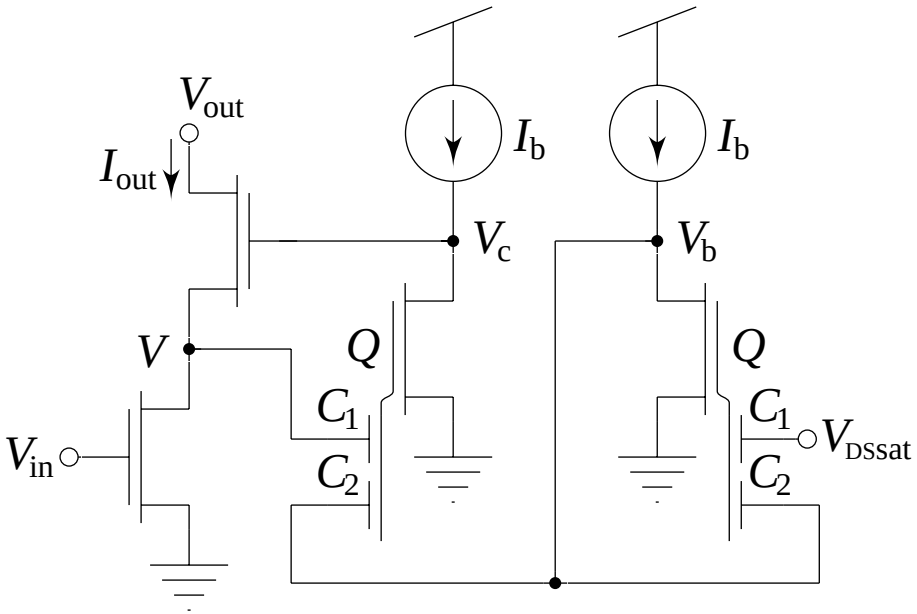

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- How can we set V_b to make $V \approx V_{DSsat}$? Use indirect negative feedback!
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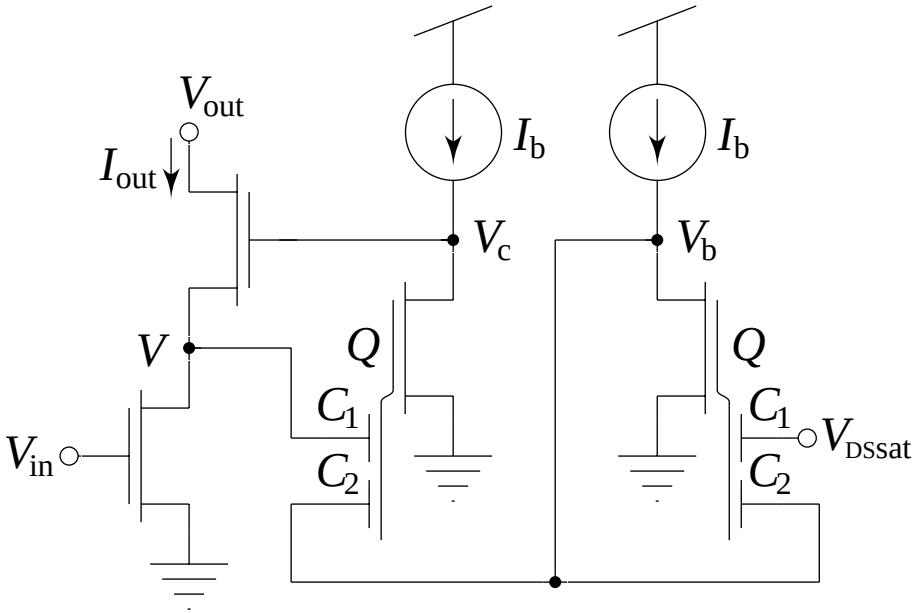
- One V_b generator can be shared by multiple regulated cascodes.



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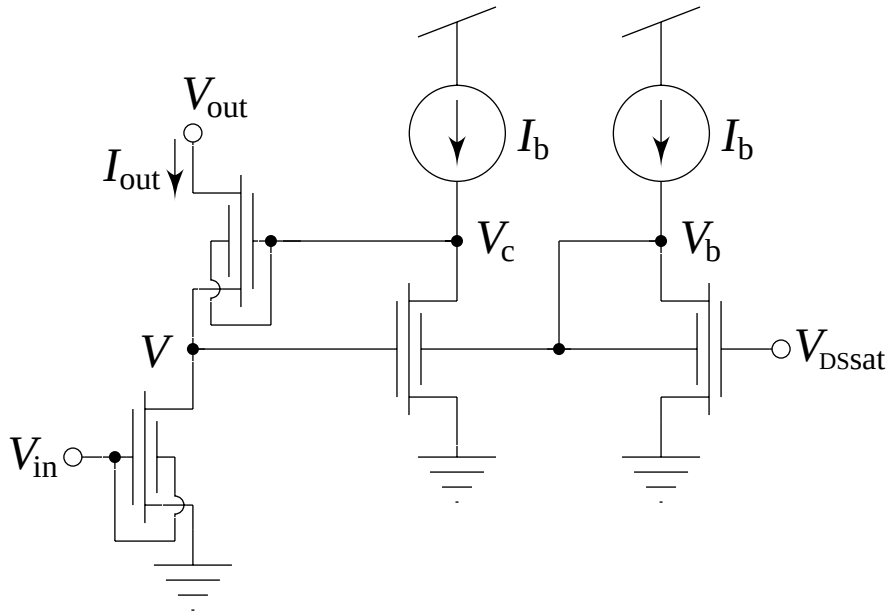
- A DGMOS version of this wide-swing regulated cascode circuit should be feasible.



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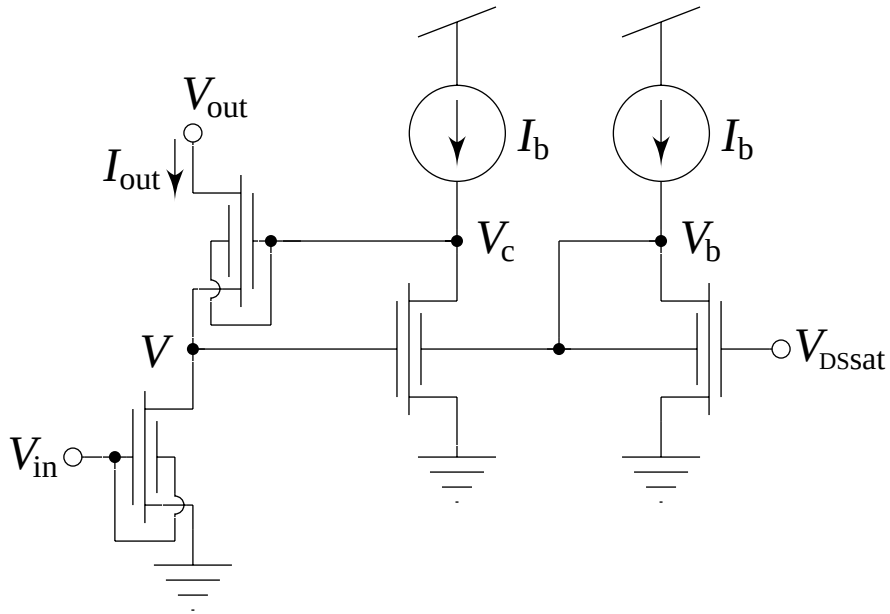

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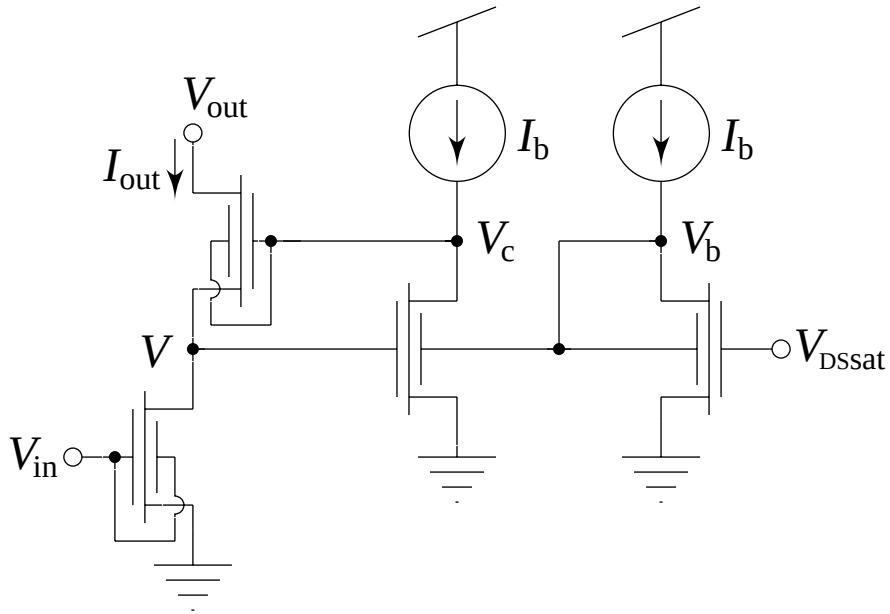

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- Requires independent access to front and back gates.
- Requires that the front and back gate voltages affect the channel current in a (qualitatively) symmetric manner.
- Desirable for the threshold voltages of the front and back gates to both be positive.