VLSI group, IIT Madras

Search

- Home
- People
- Research
- Publications
- Teaching
- Prospective Students
- SMDP
- TI RAships

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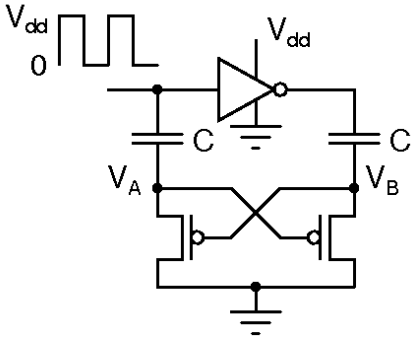
Charge pump -ve voltage generator

Goals

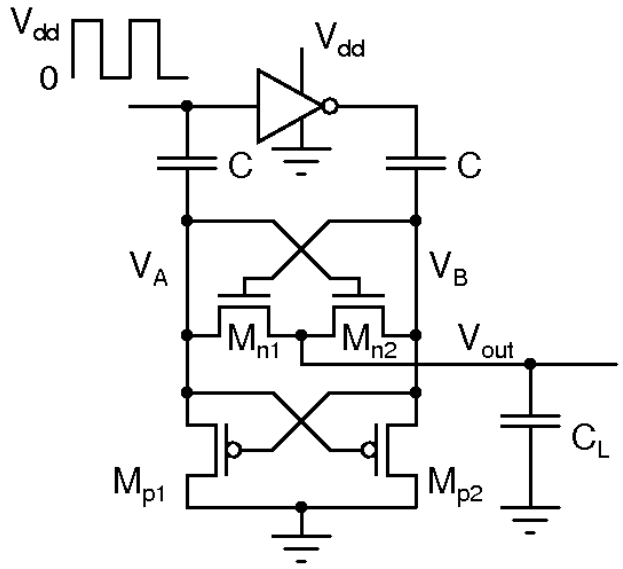
- Design a negative voltage generator from a positive supply.
- Design a circuit to get a higher voltage than the available supply

Preliminaries



- Analyze the circuit in the figure above. Determine the waveforms V_A and V_B in steady state. This requires a careful evaluation of the region of operation of the MOS transistors.

Experiment



- Transistors Mn1 and Mn2 are added to multiplex V_A and V_B and result in V_{out}. Implement this circuit using CD4069 inverters. Think carefully about which terminal goes where! You'll need to use separate ICs for the inverter and the rest of the circuitry because, on a chip, the supply and ground pins are all shorted together. You can use clock frequencies in the tens of kHz range, capacitors in the 10nF range, and a supply of 5V.
- What is the output voltage V_{out} with no load(C_L)? and with a constant current load I_L?
- Build and demonstrate a circuit that gives a positive output of approximately twice the power supply wrt ground.

Applications

- This is useful when a dual supply is required to be generated from a single supply, such as a battery. Such circuits are used in audio amplifiers which, when operated from a dual supply, have a quiescent output of 0V and hence don't need a bulky ac coupling capacitor. These circuits are also used when a small portion of the IC needs a higher supply voltage, but multiple power supplies can't be used. Examples are flash memories(USB sticks) and EEPROMS which operate from a low voltage supply(3V-5V in a mobile phone/MP3 player) but need a high voltage(~ 15V) for write/erase.