ESE 370: Circuit-Level Optimization for Digital Systems

Project 2 Milestone: FIFO Queue

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Bitline Capacitance

TODO

Circuit Schematics

TODO

Memory Column Driver Schematic

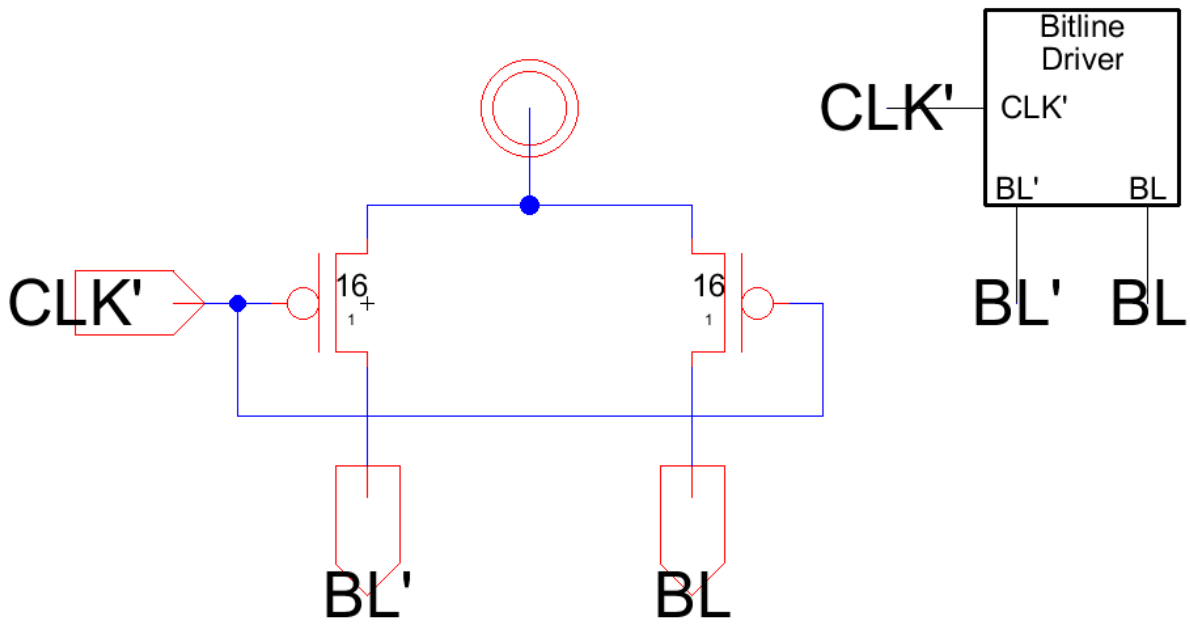

Figure 1: Bitline driver circuit

Sized Memory Cell Schematic

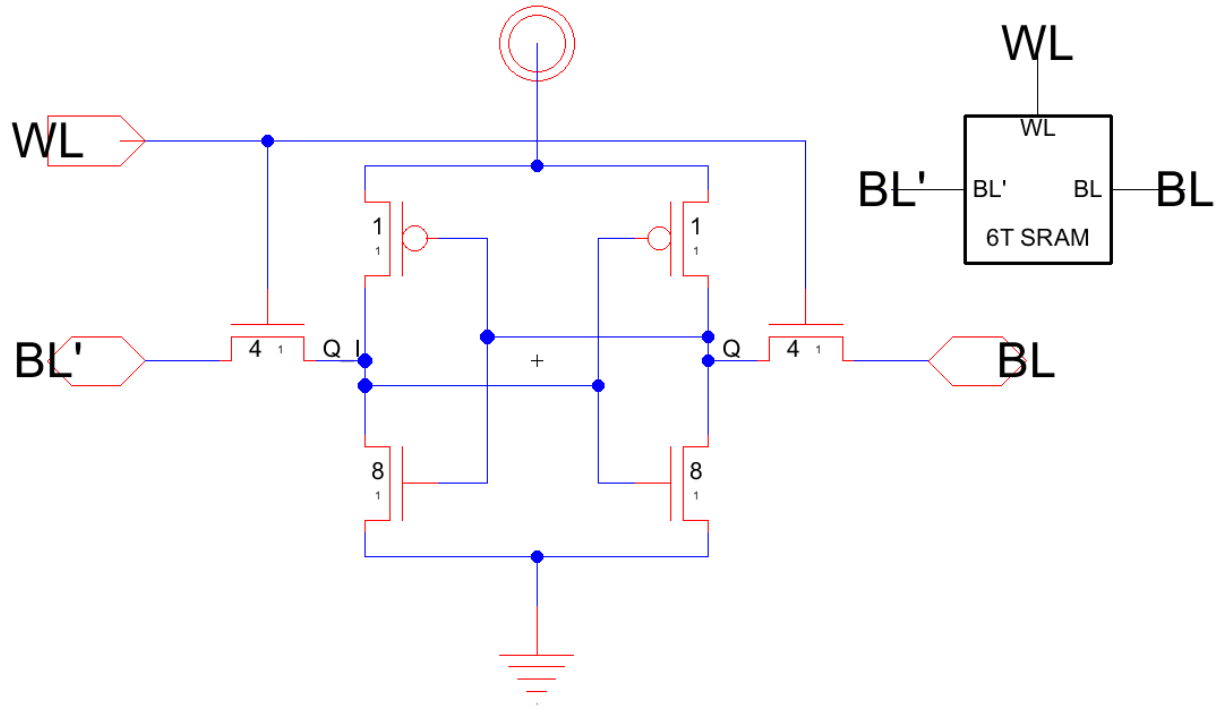

Figure 2: Sized SRAM memory cell circuit

Tri-State Buffer Schematic

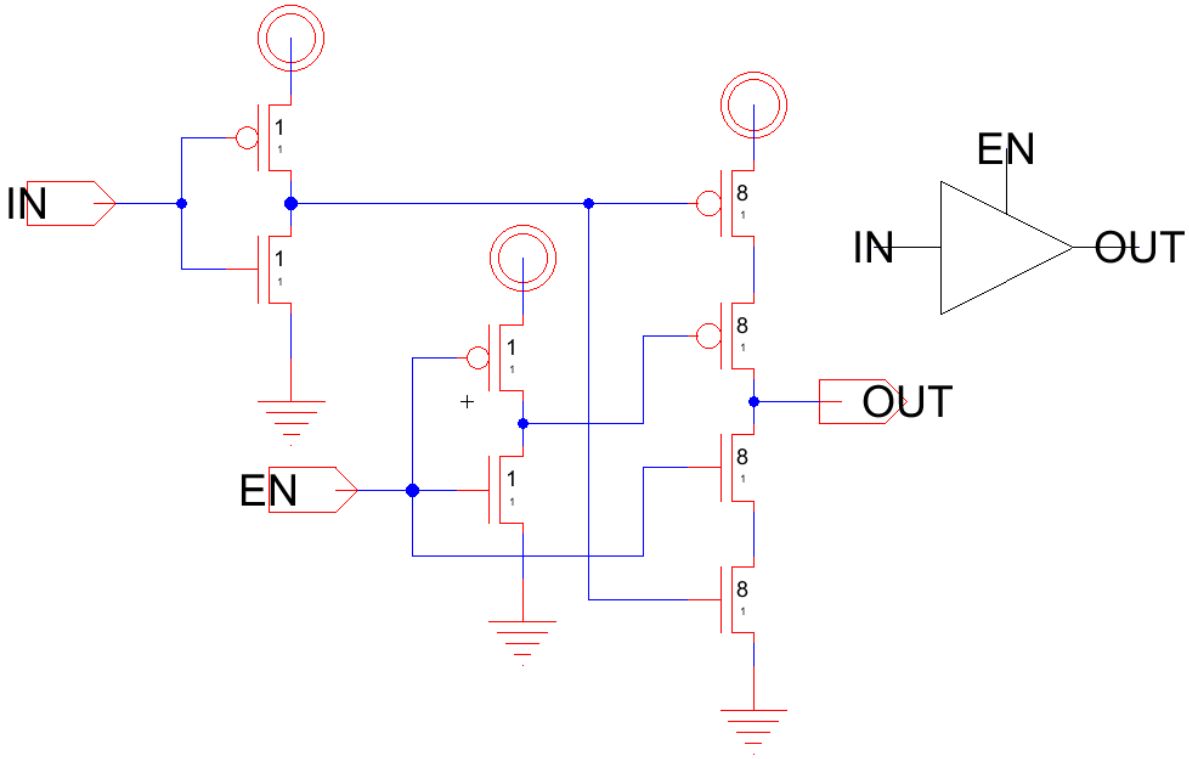

Figure 3: Tri-state buffer circuit

Tri-State Inverter Schematic

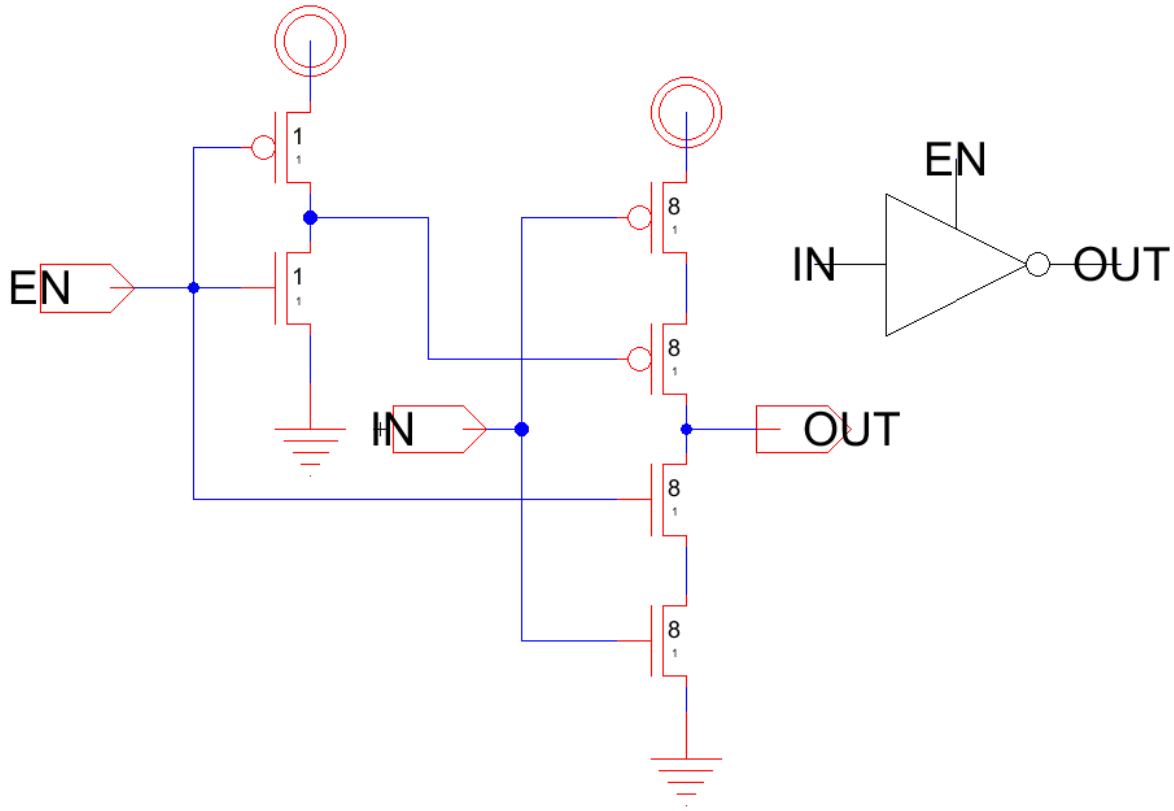

Figure 4: Tri-state inverter circuit

Reading and Writing (Cell)

Test Cases to Consider

For writing to the cell, we considered four cases:

1. Writing a 0 to a cell with 0 (Figure 11). We first write a 0 by driving BL low and BL′ high by driving $write_enable$ high, and driving WL to high. We then write a 0 again using the same process. The Q and Q′ signals inside the cell were verified to ensure that writes were being completed properly, even after $write_enable$ was set low.
2. Writing a 1 to a cell with 0 (Figure 10). This uses the same process for writing a 1 as for writing a 0, but BL is driven high and BL′ is driven low.
3. Writing a 0 to a cell with 1 (Figure 8). Since the cell already starts in a state in which Q is high and Q′ is low, we only need to write a 1 to verify this case.

4. Writing a 1 to a cell with 1 (Figure 9). This is the same case as (3) in that the cell already starts with $Q = 1$, but we instead write a 1.

Since there are two present states ($Q_t = 0$, $Q_t = 1$) and two next states ($Q_{t+1} = 0$, $Q_{t+1} = 1$), these four cases completely test writing to the cell.

For reading from the cell, we considered two cases:

1. Reading a 0 from a cell that was written to 0 (Figure 6).
2. Reading a 1 from a cell that was written to 1 (Figure 7).

In each reading case, we made sure that the reading process did not cause enough of a read upset to overwrite Q. These read upsets are not visible in Figures 6 or 7 and were on the order of tens of millivolts, so we are confident that reading from these cells is not destructive.

All testing was done with the test circuit in Figure 5. Note that this test circuit includes only one SRAM cell to keep the image visible. Actual testing was done on one SRAM cell with 15 other SRAM cells loading the bitlines in parallel to simulate how the memory circuit would behave in the actual 16-word FIFO queue.

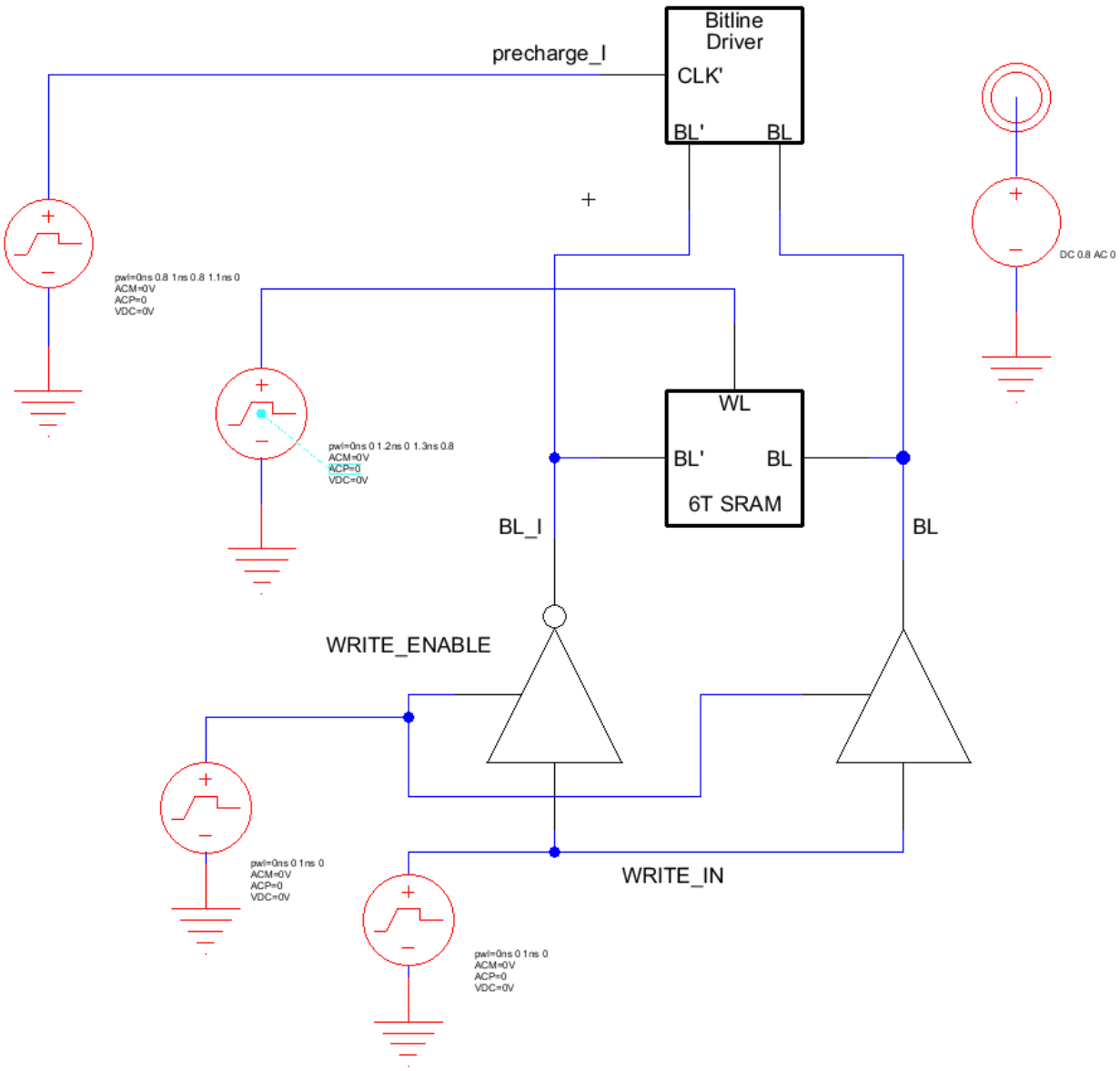

Figure 5: Memory cell test circuit

SRAM Cell Test Results

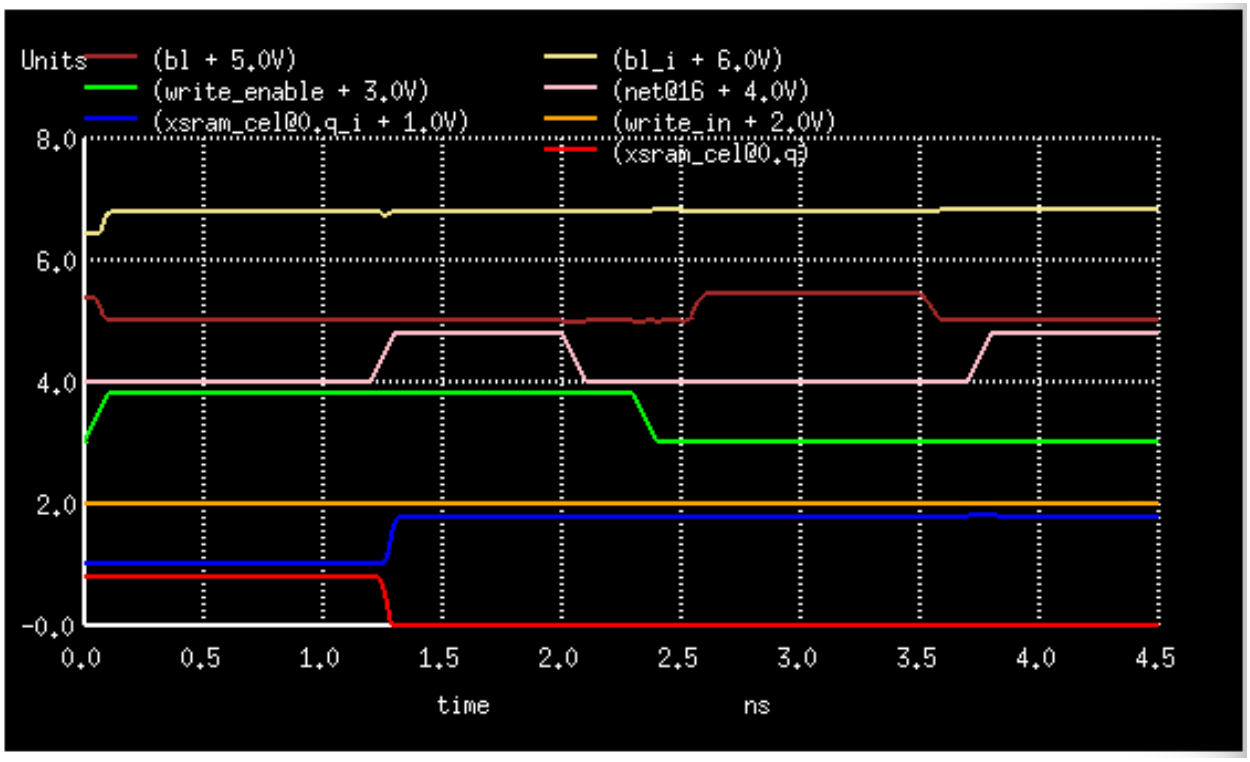

Figure 6: Writing 0 and then reading 0

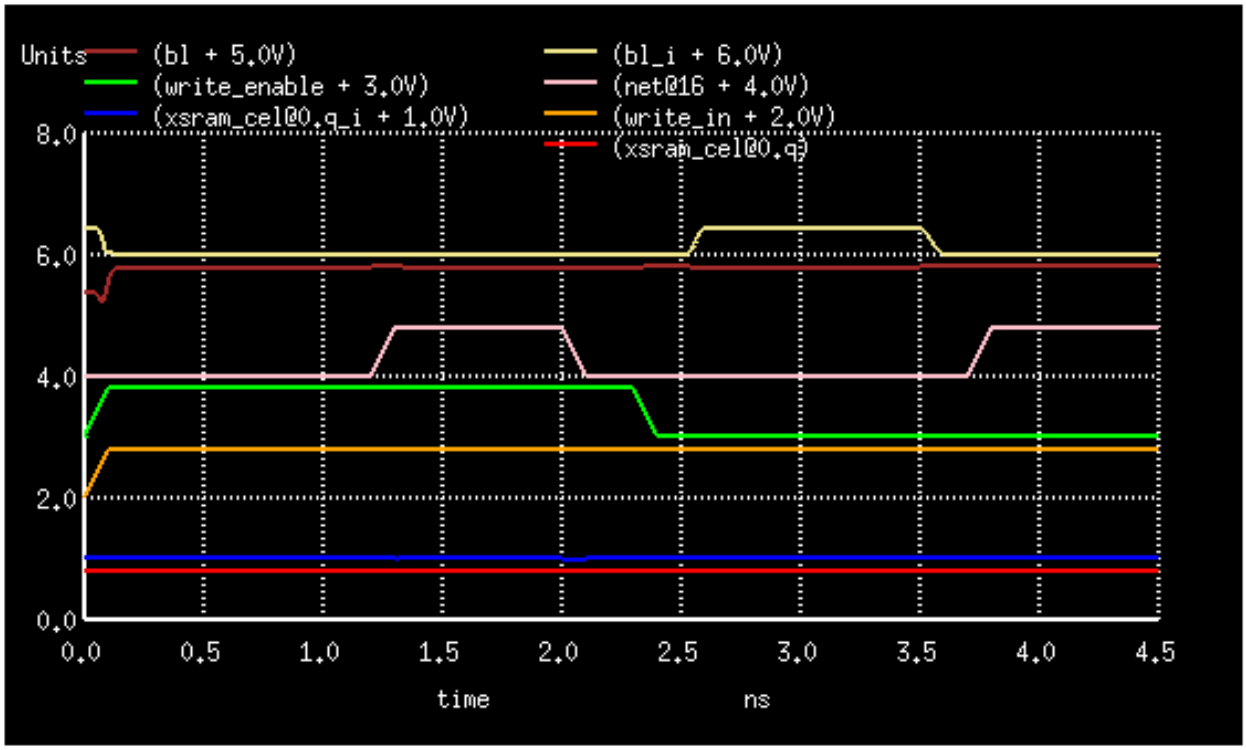

Figure 7: Writing 1 and then reading 1

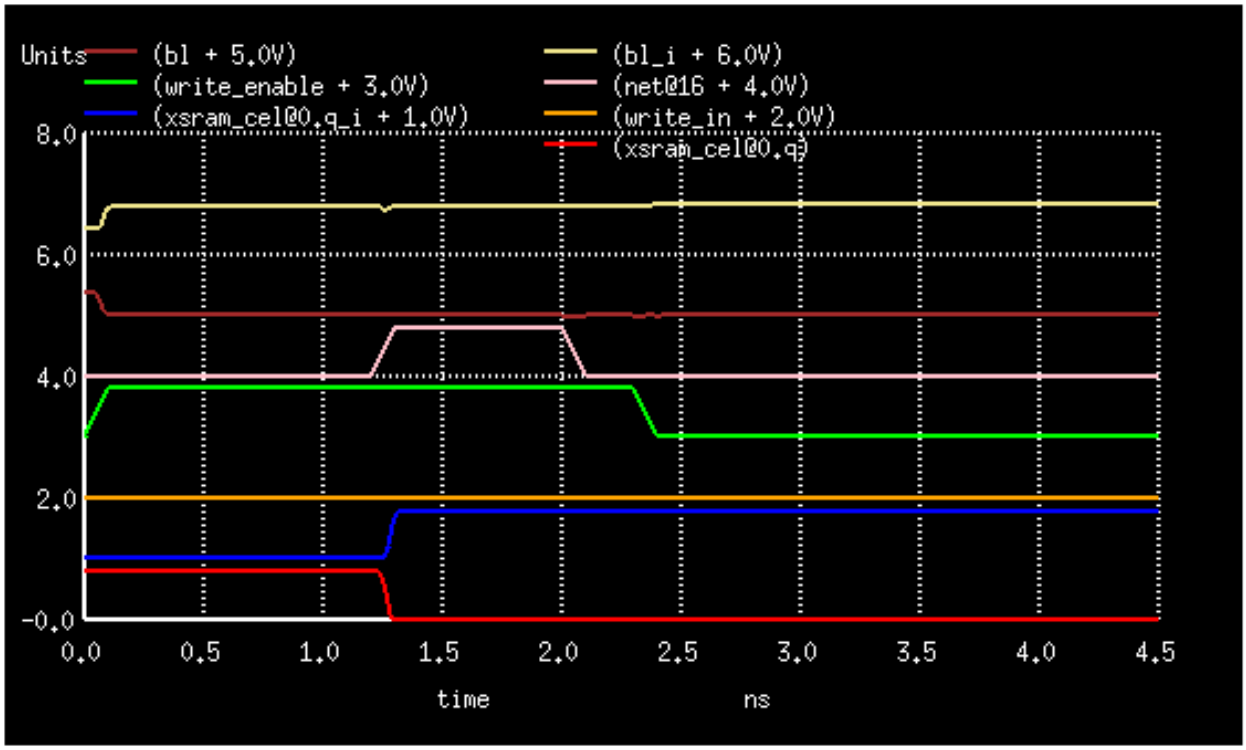

Figure 8: Writing 0

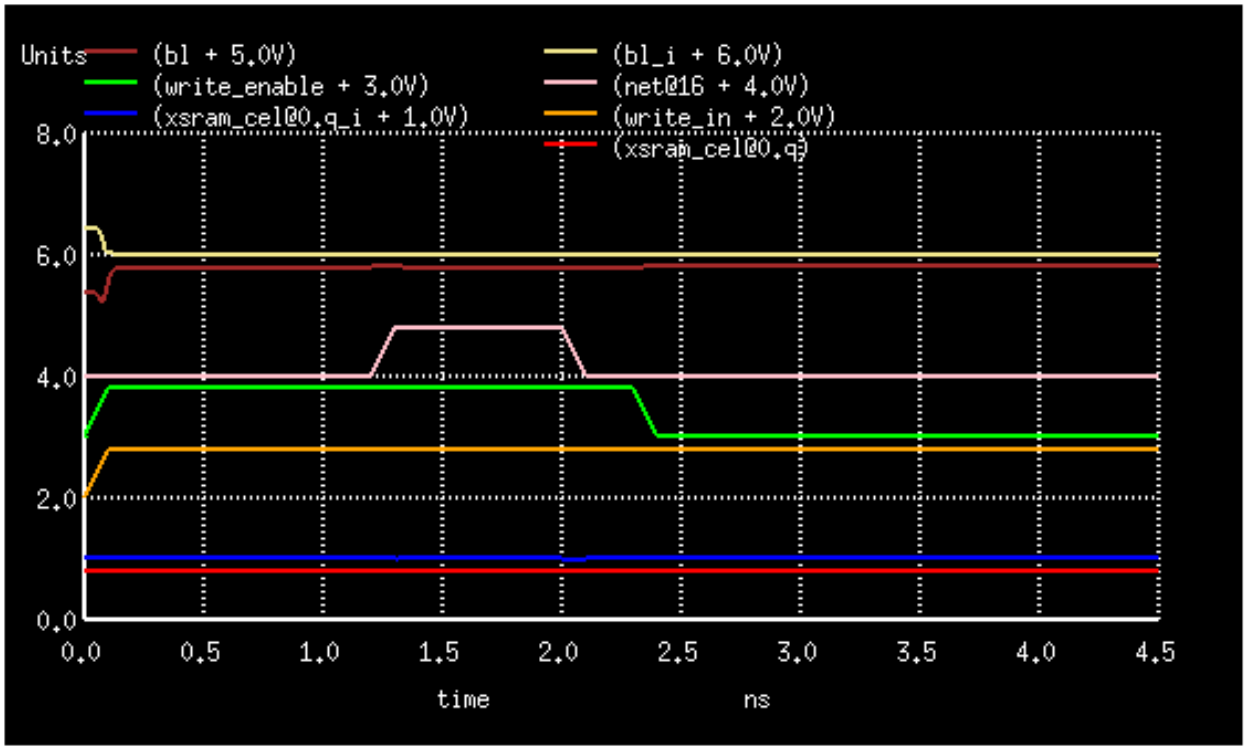

Figure 9: Writing 1

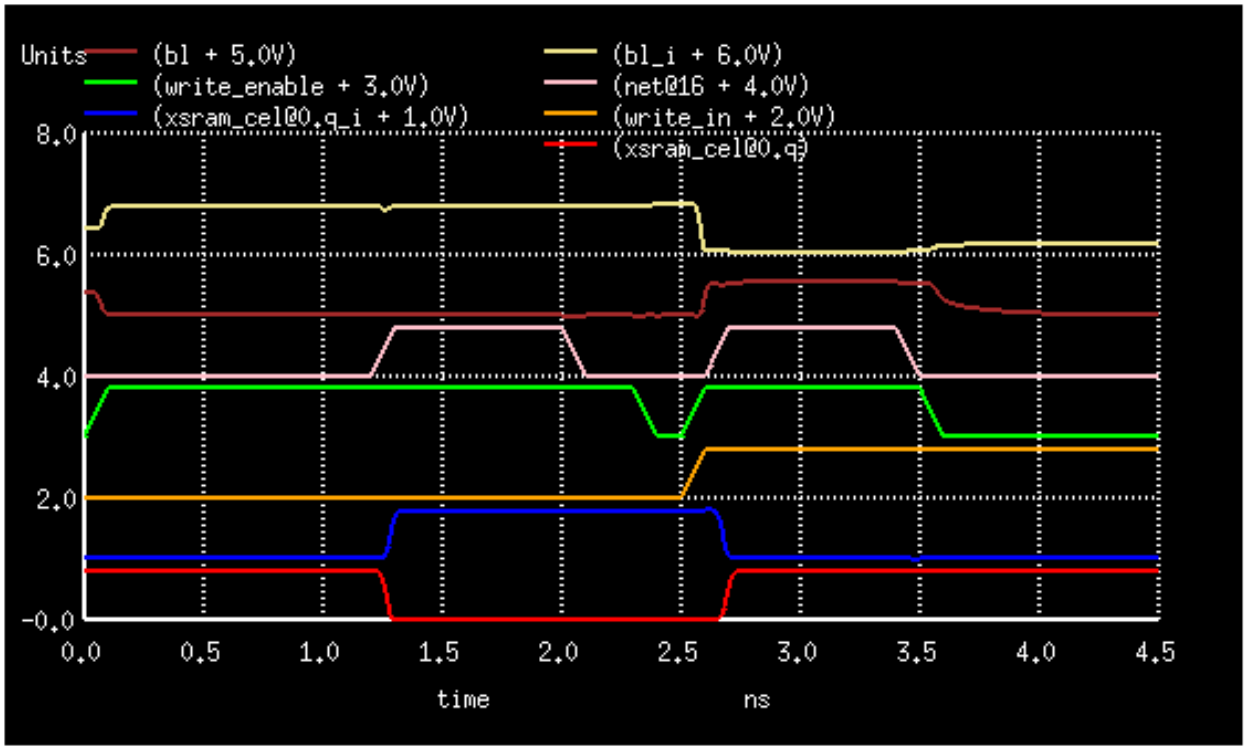

Figure 10: Writing 0, then writing 1

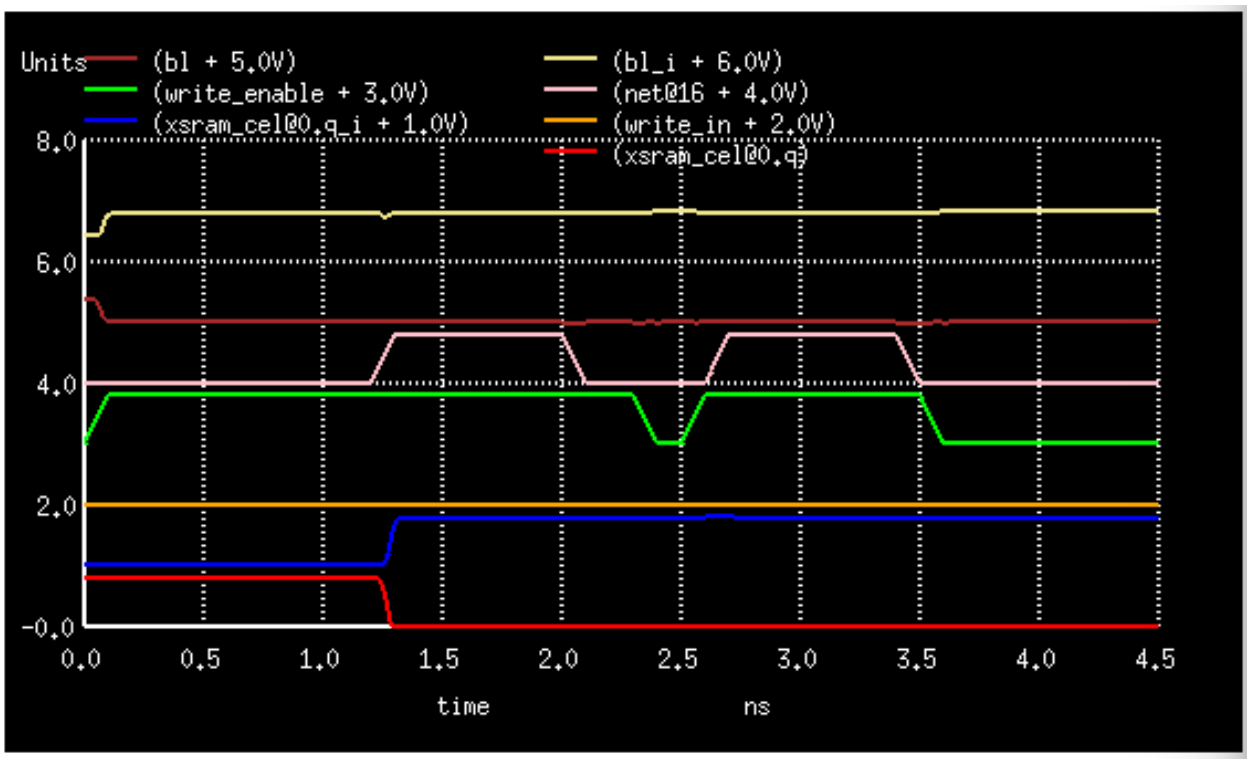

Figure 11: Writing 0, then writing 0

Constraints on Write Timing, Full FIFO Design

TODO