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ECE 150B

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Project 3: Memory

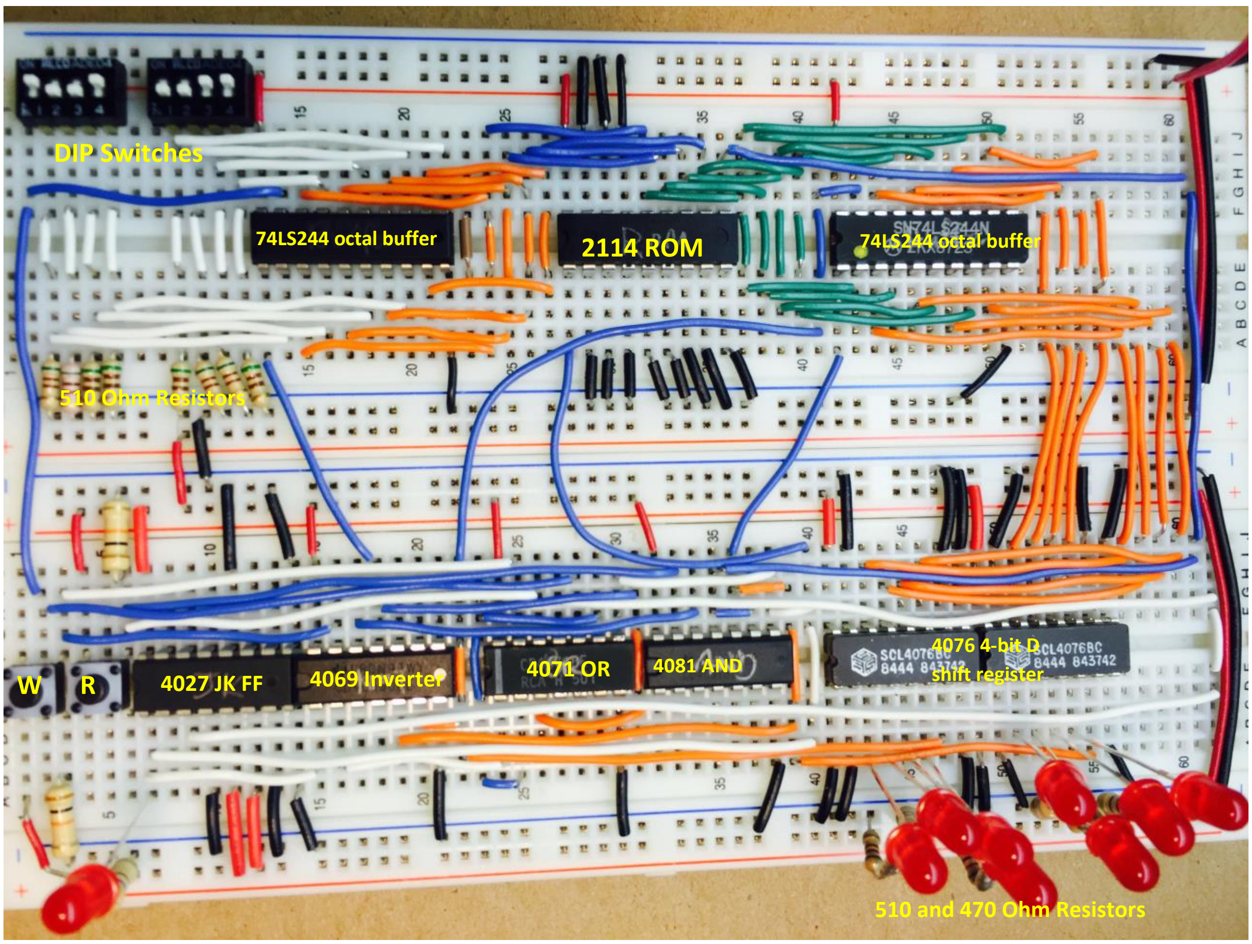
**Abstract**

This project aims to construct a circuit that can store an 8-bit binary number using one 4-bit memory chip. By assigning 4 bits to each address at a time and temporarily storing in two shift registers, the combined 8-bit output was obtained, indicated by 8 LED's

The project specification required a circuit that stores, retrieves, and displays an 8-bit number, the use of two 4-bit memory addresses, two 4-bit DIP switches to input 8-bit number, output using 8 LEDs, and two buttons, each of which is used to read and write.

**Diagram**

Image 1 [Top view]



**Explanation of Design**

1. *Inventory of parts (#)*
    - Push toggle switch (2 units)
        - These switches were used to enable read and write mode of data. One of the switches acts such that it enables the buffers and the other, similarly, controls buffer enables and clocks for shift registers.
    - 4027 [JK Flip Flop] (1 gate)
        - The purpose of a JK flip flop was to toggle the output such that the address pin on the memory can be switched.
    - 4081 [AND] (2 gates, 1 chip)
        - Used for logic for n(enable 3) and outputting write enable for the memory.
    - 4071 [OR] (2 gates, 1 chip)
        - Used for logics for n(enable 1, 2).
    - 4076 [4-bit D-type PIPO shift registers] (2 units)
        - 4-bit D-type shift registers were necessary to store a 4-bit binary number and then retrieving later for a complete output of 8-bit number. They were to hold the output until another rising clock pulse.
    - 4069 [Inverter] (2 gates, 1 chip)
        - Used for logics for n(enable 4) and logic for write enable for the memory.
    - 74LS244 [Octal buffer] (16 gates, 2 chips)
        - Buffers were used to activate transfer of data when necessary. They allowed for the control of data flow easily.
    - Dip Switch
        - To provide two 4-bit binary inputs for the memory
    - Resistors ( 10 kΩ, 510 Ω, 470 Ω)
        - 10 kΩ resistors for the push button were used to give enough resistance when contact is applied, 470 Ω, as manufacturers recommend, was for the LED's, and since there no more 470 Ω left available in the lab, 510 Ω was used instead inevitably.

    a. 8 LED's
        - Since red has the lowest resistance of all colors available for us to use, typical red LED's were used for indicating the bits written and read in the memory addresses.
2. *Color Coding*
    - Red: Vdd
    - Orange: used for outputs from the first set of tristate buffers, data outputs from the second set of tristate buffers that are inputted into data in of the shift registers
    - Blue: used to put data outputs from the first set of tristate buffers into the data in to an address of the memory, inputting enable and write enable signals.
    - White: used for inputs from the DIP Switches into the first set of tristate buffers, button inputs into the clock of JK flip flop and transferring the output of the flip flop.
    - Green: used for data outputs that are inputted to the second set of tristate buffers
    - Black: Vss

3. *Problems encountered*
    - Not enough space for all the connecting wires to be placed in a neater appearance
    - Some wires had to be tightly placed
    - Interference between the wires
    - Conflicting outputs / unstable outputs
    - Limited resources (resistors, dip switches, buttons, etc.)

**Design**

*Rationale for Design*

Two full breadboards were used to place all necessary chips for the logics. I divided each breadboard by its primary function—one for the overall function (buffer-memory-buffer-output) and another for the switch control logic. Since shift registers required more space on the first breadboard, they were placed on the switch breadboard.

An LED was used to signal the pressing of either of the buttons. Since both button signals are used for the clock of the flip flop, the output toggle signaled pressing of either button. The buttons and the chips were placed next to each other, just enough for a couple of wires to cross, in order to reduce the use of space.

As for wiring, a few connecting wires need to cross over the breadboard, and in doing so they need to be bent inevitably, due to the limited space available. Each line on each breadboard was used for some signal, and it prevented from neatly getting the wire across. The color coding was maintained in order for easier debugging process.

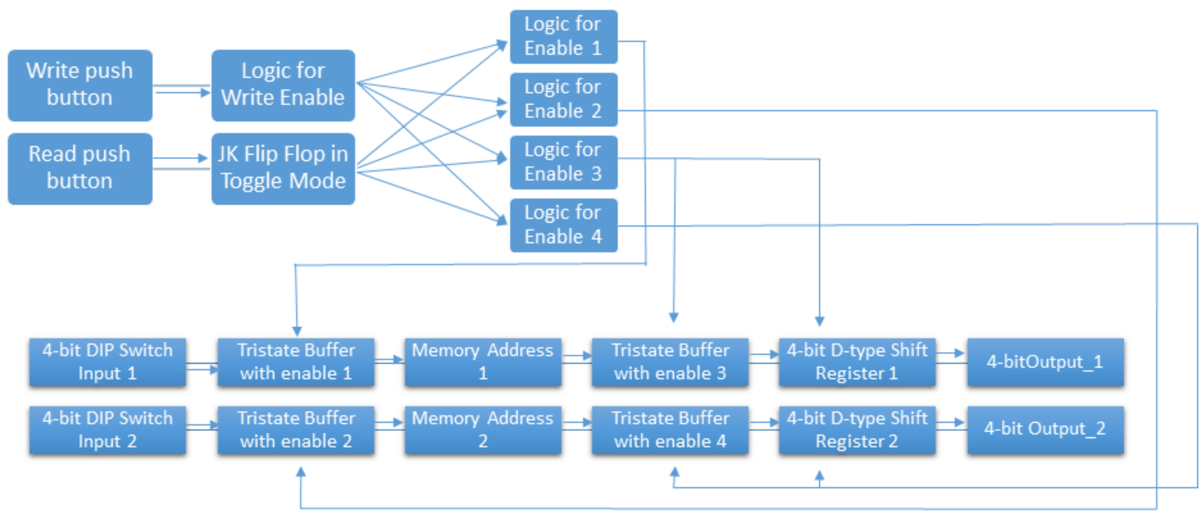
There were some restrictions in the amount of available resources. Resistors of 470 ohm were no longer available due to high demand, which were then replaced by 510 ohm resistors. Dip switches and buttons available for use in the lab were not the best, so they caused some trouble while it was running. This required further stabilization process.

All floating inputs were either grounded or handled such that they wouldn't interfere with the logics involved near them.

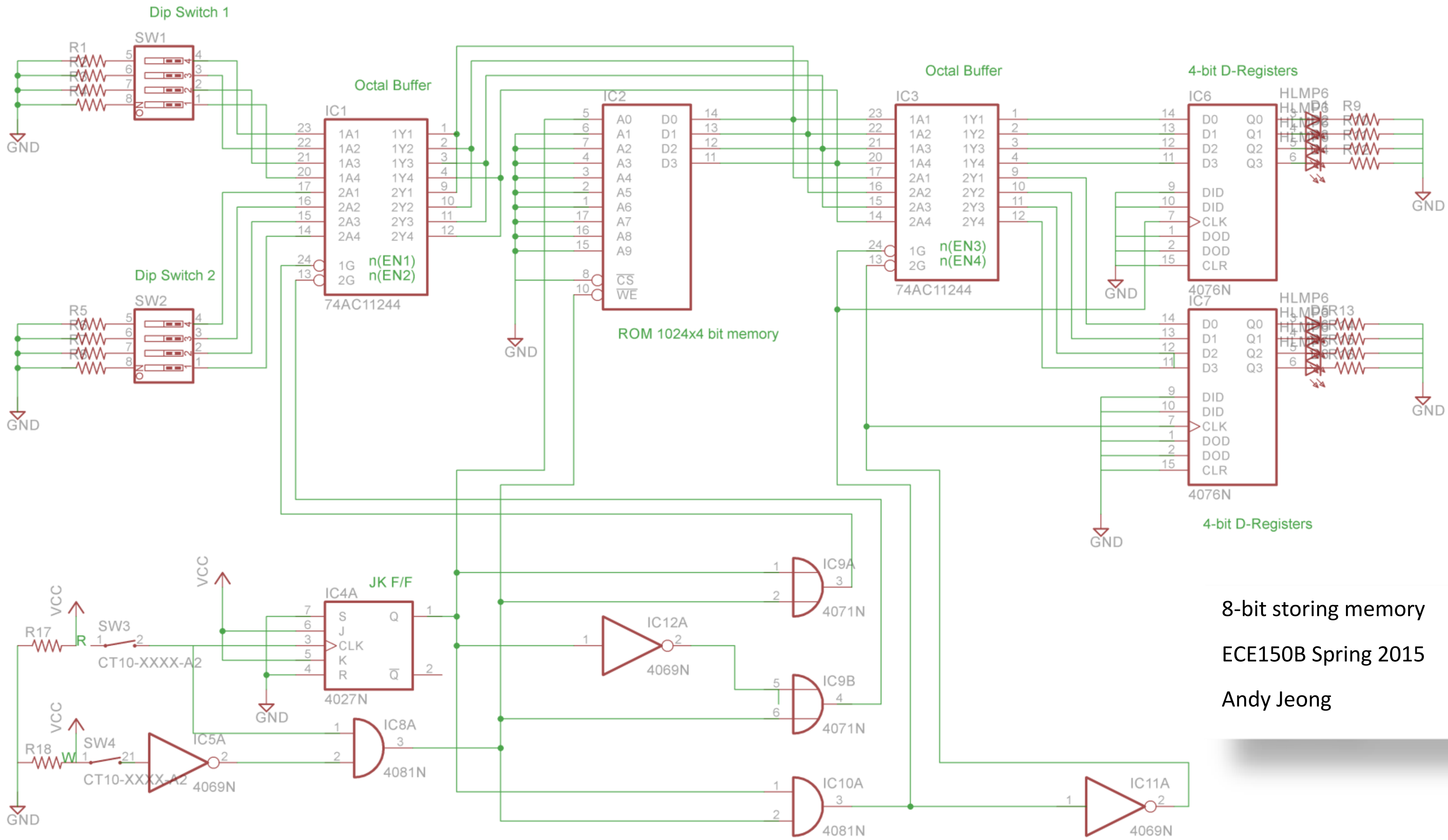
*Functional Table*

| ***Mode*** | ***n(WE)*** | ***address*** | ***$CLK_1$*** | ***$CLK_2$*** | ***$n(EN_1)$*** | ***$n(EN_2)$*** | ***$n(EN_3)$*** | ***$n(EN_4)$*** |
|---|---|---|---|---|---|---|---|---|
| *Write* | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| *read* | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |

*Functional Block diagram*



## Schematic Diagram




8-bit storing memory

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