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The Lab 8 Write-Up

June 7, 2016

Description

The purpose of this lab was to implement logic designs in bread boards rather than the Xilinix ISE program we have been using for the class. To implement logic designs on a bread board, Integrated Circuits (IC) were used. The goal of Part 1 was to create a ring oscillator with 9 inverters and an edge triggered Flip-Flop. An oscilloscope was then used to measure the propagation delay of the inverters. In the next part, an edge triggered Flip-Flop was created using logic gates. I chose to use NOR gates to create a negative edge triggered Flip-Flop.

Description:

To begin, the IC with inverters was called HD74LS04P. This IC contains 6 inverters, so two of these ICs were used since the ring oscillator for Part 1 needed 9 inverters. After looking up how each pin was connected I designed wire destinations for the pins on the IC. After the designing process, I implemented my design on the board. After this, I went on to using the mustimeter to determine which pins in the power adapter were VCC and GND. I Then connected the adapter to the board, and a fuse from the row with the VCC pin to the red column on the side of the board, so VCC could be easily accessed on the edge of the board. For ground, a wire was used to connect GND to the blue column on the edge of the board to distribute ground to the whole board. Then 2 wires were used to send these connections to the columns on the opposite side of the board, so VCC and GND were accessible on both sides of the bread board.

Next I plugged my circuit into power and read the readings on the oscilloscope and calculated the propagation delay. After this, I repeated the design process for the Flip Flop. When it came to adding LEDs to check my result I calculated the resistance I needed for each LED and connected the LEDs as instructed by the lab manual. I then tested my design to see that it worked.

Results: Part 1

After looking up the instructions on how the pins are mapped I drew the schematic in Figure 1.

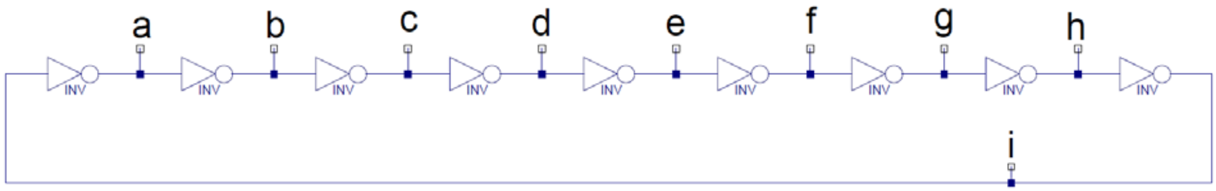


Figure 1: Ring oscillator with 9 inverters.

Using the letter encoding in Figure 1, I implemented this design with the two inverter ICs. My result, using the encoded letters in Figure 1 can be seen in Figure 2.

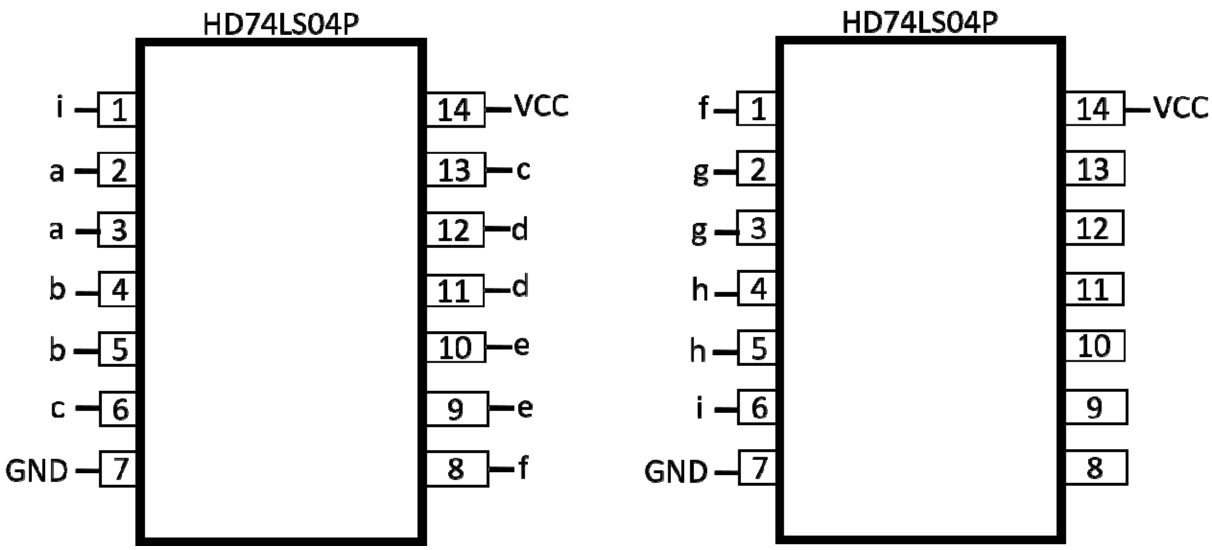


Figure 2: Ring counter implementation in ICs

Once the Oscilloscope was connected to my breadboard, I calculated the delay to be $\frac{1\times.2\ ns}{2\times 9} \approx 11\ ns$. This seems accurate since according to the manual, the delay should be between 9 and 15 ns.

Results: Part 2

To implement a D-Flip Flop using NOR gates, I used the schematic in Figure 3.

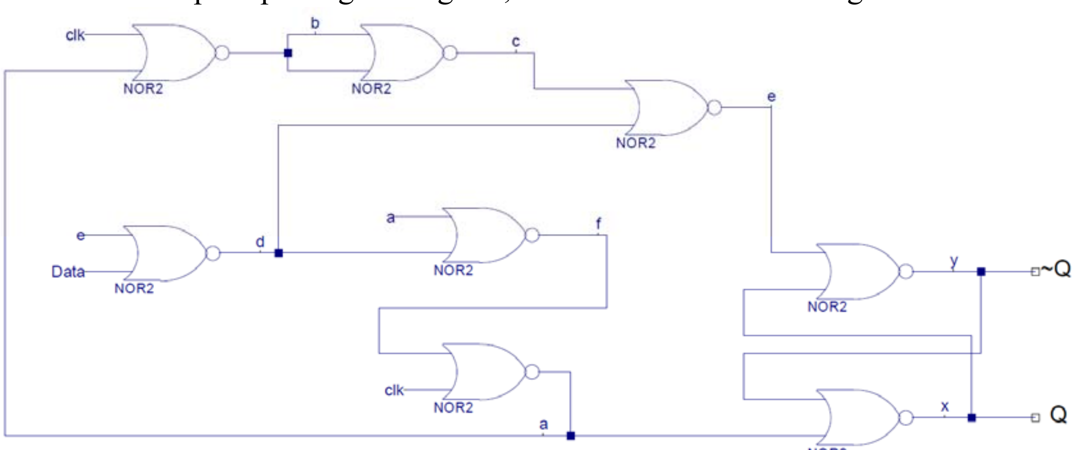


Figure 3: D-Flip Flop NOR implementation

Just like in Part 1, I then mapped the schematic to the ICs. Two HD74LS02P ICs were used to implement the logic in Figure 1. Once again, the encoded lettering in the schematic matches the lettering in the IC Figure. My IC implementation can be seen in Figure 4.

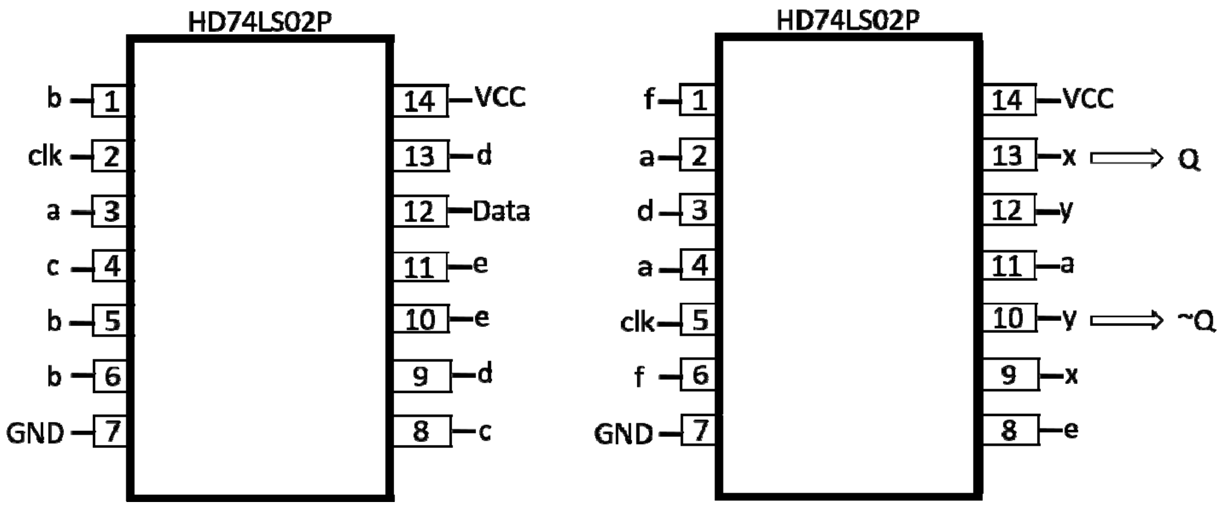


Figure 4: IC Implementation of an edge triggered Flip Flop.

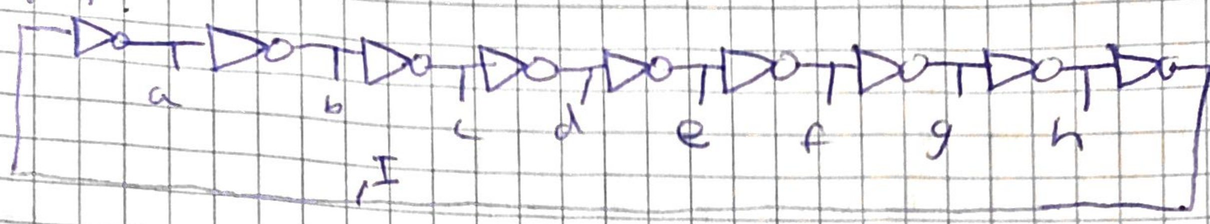
For the Data input, Q and $\overline{Q}$, LEDs were connected so I could test the design. In order to power the LEDs, I first needed to calculate the resistance needed for the LEDs. The current entering the LEDs had to be restricted to 20 mA. First I found the V_L for each light by measuring the forwarding voltage, V_F and the voltage of the IC output, V_X. Using the formula: $V_L = V_X + V_F$, V_L was found to be 1.73 V, 1.78 V, and 1.71 V for the red, green and yellow LEDs respectfully. Multiplying these values by 10^3 and dividing the result by the 20 mA restriction, the minimum resistance necessary for the red, green and yellow LEDs came out to be 163 Ω, 69 Ω, and 85Ω respectfully. These resistances were very low compared the provided 1,000 Ω, and 2,200 Ω resistors provided. I was working with Calvin Chopra when calculating these values and found it strange that the values were very low. I ended up using 1,000 Ω resistors for all the LEDs.

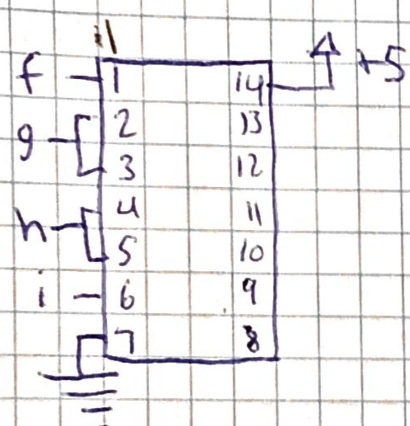
Conclusion

In this lab we used logic design to accomplish simple tasks on physical logic gates through ICs on a breadboard rather than the Xilinx ISE program. This was my first time working with a breadboard, so everything done from understanding how the board works to how to connect LEDs to resistors was all new to me. All my results worked the first time I attempted them so there is nothing I would do to change my design process or my design.

Lab 8

Part 1:





$$T_{delay} = \frac{1 \times 0.2\ \mu s}{2 \cdot 9} = \cancel{.00111\ \mu s} = \boxed{11.11\ ns}$$

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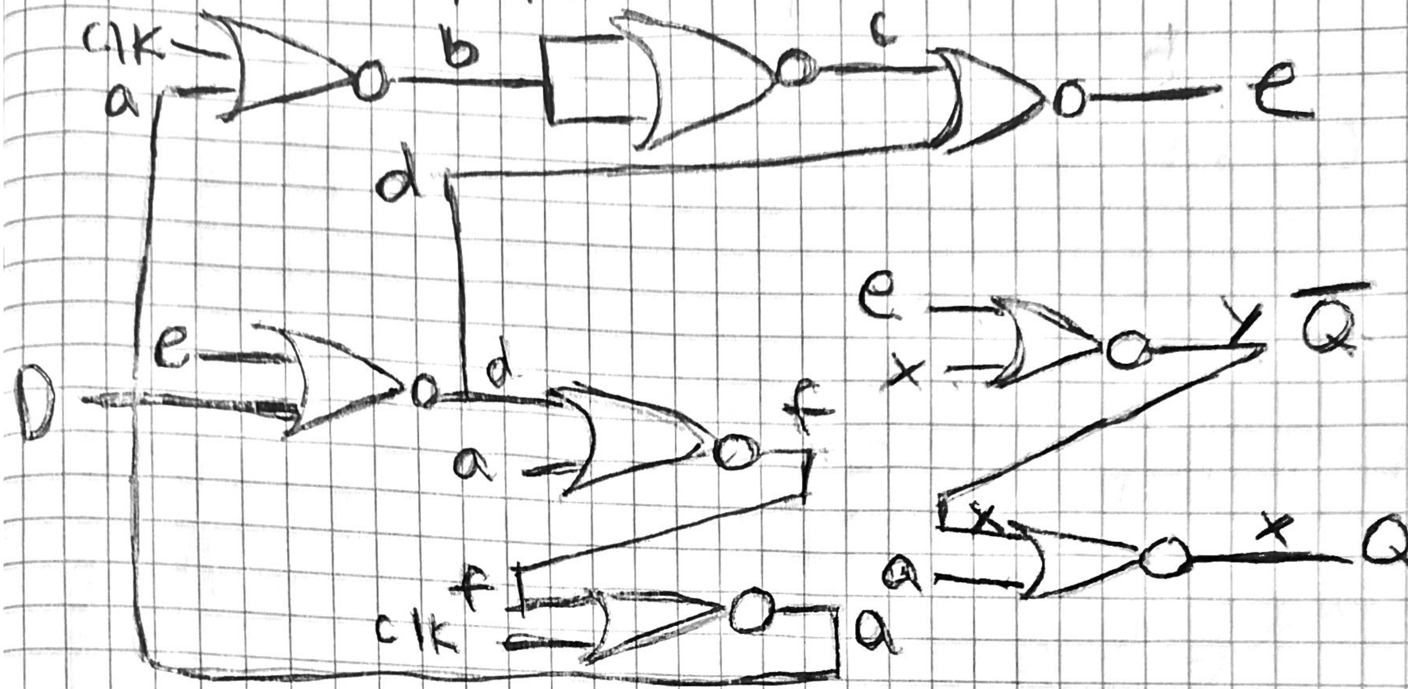
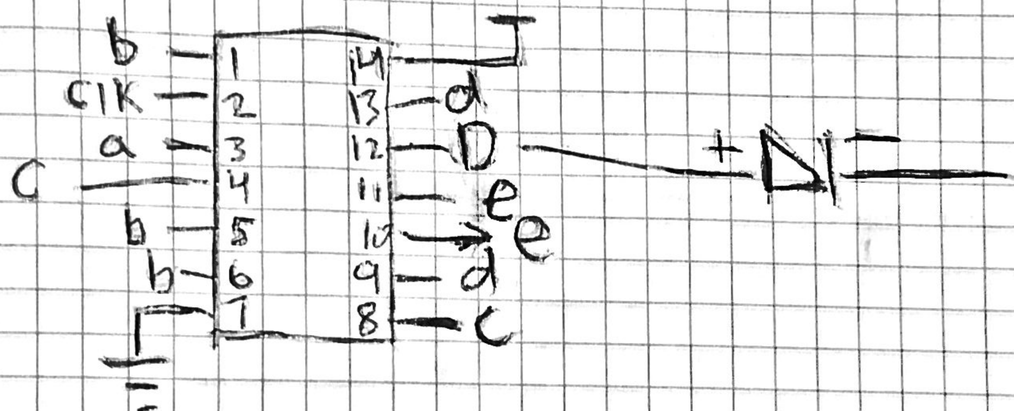
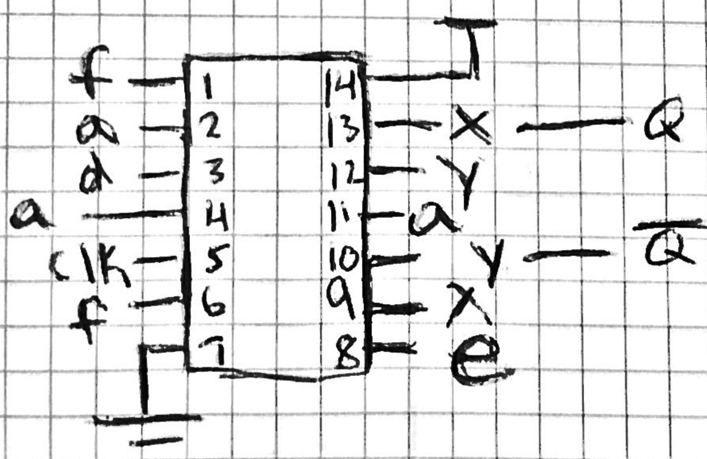
Part 2







Part 2
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LED Resistance

~~Green~~ Red

$V_L = 1.73 \times 10^3$ $V_x = .082\,V$

$\frac{V_L}{20}$ $R \leq 163\,\Omega$

Green

$V_L = 1.78 \times 10^3$ $V_x = 4.67\,V$

$\frac{V_L}{20}$ $R \leq 69\,\Omega$

Yellow

$V_L = 1.71 \times 10^3$ $V_x = 5.02\,V$

$R \leq 85\,\Omega$

$\frac{V_L}{20}$