Lab 1: HCMOS Logic Family

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In this lab you will get a hands-on experience designing simple logic circuits using standard integrated circuits (ICs). You will learn about timing and its effect on the circuit output.

Contents

1 Prelab

1. Write the truth table for an inverter gate.
2. Write the truth table for a *xor* gate.
3. Write the truth table for a *and* gate.
4. Write the truth table for the circuit given in Figure 1.

2 Lab

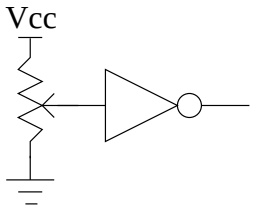
2.1 Basic Behavior of HCMOS Logic Family

1. Use the datasheet to connect a 7404 IC.

Figure 1:

2. Verify the operation of the inverter by connecting the input to V_{cc} and GND.

3. Use a variable 10kΩ pot to vary the input to the inverter. When does the output change.



4. Build the circuit shown in Figure 1 using 10 inverters in series. Set the output of the function generator that you build in Lab 0 to 15 kHz and connect it to the input of your circuit. Can you observe the output of the your circuit by using a voltmeter or a logic probe.

5. Connect the output of your circuit to the logic analyzer and record your observations. (Use the information provided in 3.1 to run the logic analyzer).

6. Does the output match what you expected? Why or why not?

7. What is the propagation delay of an inverter gate?

2.2 Half Adder

1. Write the truth table for the circuit shown below.

2. Connect ICs from the 7400 family to implement the circuit shown above.

3. Verify the operation of the circuit by connecting the inputs to different combinations of V_{cc} and GND.

4. In terms of binary arithmetic, what do the S and C outputs represent?.

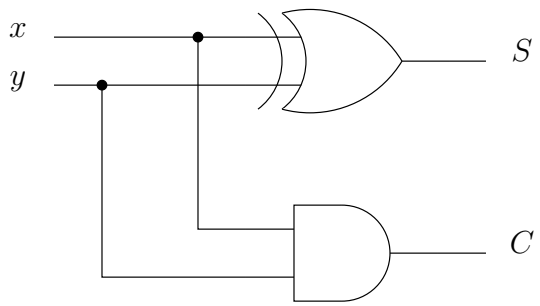


Figure 2: Half Adder

3 Supplementary Material

3.1 Logic Analyzer

Start the logic analyzer by double-clicking on the LA Viewer icon on the Windows desktop. Do the following:

1. From the Clock menu in the upper right corner of the LA Viewer window set the internal clock for a 5MHz sampling rate.

2. Right-click in the leftmost column of the viewing area and select delete all labels.

3. Right-click in the leftmost column of the viewing area and select add label. Add representative names and select the appropriate channels.

4. Click on the button with a single running man. The logic analyzer will sample the logic levels on lines 0 and 1.

5. Observe the Waveform window. You can use the `Magnifying Glass` icons on the menu bar to zoom in and out. Does the waveform make sense to you? Print a sample of the waveform, and put it in your lab notebook. To print a copy of this waveform, make sure the logic analyzer software is in the foreground (it is the current program). Then, press Âlt+PrintScrn to take a snapshot of that window. You can now paste this image into Word which will make it easy to print out.

6. Another way of displaying logic data is as numbers. Right-click on the leftmost column, select combine labels, give this label any name, move all labels from source box to destination box where output is at the top, and the is at the bottom and click OK. Right click on that name, select Configure Labels, and change Group Type to binary. How does this numeric data compare to a truth table format?