EE 231 Lab 1
Fall 2005

Introduction to HCMOS Logic Family

Objectives. The objectives of Lab 1 are to introduce you to your digital lab kit, and to some of the characteristics of the HCMOS family of digital logic. Your digital lab kit includes the parts will will need to do most of the experiments in EE 231L. You will use the protoboard in your kit to build the circuits in the lab. Your kit includes components needed for the lab, wires for wiring your circuits, and a logic probe for troubleshooting your circuits. In later labs you will design your logic in software and download it into the EPM7064 programmable logic device (PLD) in your kit. In some of the later labs you will use a logic analyzer to verify and troubleshoot your circuits, and in the final lab you will use a larger PLD to implement a computer.

Procedure:

1. First you will need to set up your protoboard (prototype board) power supply. When wiring, a clean protoboard is much easier to work with then a “spaghetti-like” mass of wires. A clean-looking board is one that has wires just long enough to reach where they are meant to go, using red-wire exclusively for power and black-wire exclusively for ground. This will make future wiring much easier to comprehend. Keep your wires as short as possible and strip only about ¼” from the edges. If you strip too much you could end up shorting your circuit.

Power Supply

Before you can start using the wall adapter, you must have the screw-top leads attached to the holes in the top of the protoboard. Place the red screw-top (for VCC= +5V) and the black screw-top (for ground) in the far left and the far right hole, respectively. The yellow and green screw-tops should go in between them.

After attaching the screw-top leads you can connect the power supply to the protoboard. (The power supply should NOT be plugged into the wall while connecting any wires.) To connect the power supply, simply take the two leads from the wall adapter, slip the red wire into the red screw-top lead and the black wire into the black screw-top lead. Then cut a piece of red wire to connect to the red screw top lead and cut a piece of black wire to connect to the black screw-top lead. These wires then connect to the power and ground <u>rows</u> at the top of the protoboard. Plug the VCC wire into the red row with a “+” on it, and the GND wire into the blue row with a “-”.

Next connect power and ground to the four corresponding columns of the protoboard. Simply use wires to jump down from the top rows to connect the columns. To make sure you have power to your board, wire an LED in series with a 1KΩ resistor from VCC to GND in the upper left hand corner of the protoboard. Current can only pass in one direction through and LED, so if it doesn't light up the first time, the LED may just be placed in backwards.

2. Put a 74HC02 IC in your breadboard. Look in the data book to determine the correct pinout and pin assignments (Make sure **power is off** while connecting wires and components). Remember to connect the 74HC02 to V_{cc} and to ground at the appropriate pin numbers.

Complete the truth table shown below (Fig 1) by connecting two of the input pins of the 74HC02 to V_{cc} and ground in all combinations. Record the input voltages (V_A and V_B), and the output voltage (V_Y) using a voltmeter. You should also do the same measurements using a logic probe, and record the color of the logic probe for each input combination.

Before beginning measurements answer the following questions:

Which pins will you use as input?
Which pin for output?
Can other combinations of pins be used?

Logic Level Input A	*V_A (in volts)*	*Logic Probe Color*		*Logic Level Input B*	*V_B (in volts)*	*Logic Probe Color*		*Logic Level Output Y*	*V_Y (in volts)*	*Logic Probe Color*
L				L						
L				H						
H				L						
H				H						

Figure 1: Truth Table for NOR Gate

Do your results make sense?

3. Provide no input to A and B (disconnect all wires except those of V_{cc} and ground).

Using the voltmeter, measure the voltage at the inputs A and B:
$V_A =$
$V_B =$
Measure the output voltage:
$V_Y =$

Measure the same quantities using the logic probe. Do these results make sense? Does the Boolean logic make sense? Discuss any results you find and compare the results found with the voltmeter to those found with the logic probe. What are some advantages and disadvantages of using voltmeters vs. logic probes for digital measurements?

Determine the circuit response as V_{in} is varied.

4. Insert a 10 kilohm potentiometer into your breadboard.

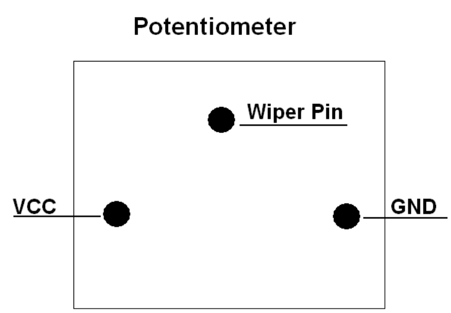

Figure 2: Pinout of Potentiometer

Connect input A to the wiper (middle pin) of the 10 kilohm pot. This will generate a variable voltage between 0 and V_{cc} at input A.
What should input B be connected to in order to obtain a meaningful output?

With A and B connected appropriately, use the voltmeter to measure V_Y as a function of V_A. Make the measurements closely spaced in the region where V_Y changes logic levels. Sketch the results in your lab book.

Now reverse the connections to input A and B (connect the wiper to input B). Repeat measurements.

At what input voltage does V_Y change states? Was this value the same for both trials? Compare this voltage to V_{IL} and V_{IH} listed on the data sheet. Did V_Y ever obtain an intermediate value (something not ~0 V or~5 V). Would you expect to find exactly the same results if these tests were performed again?