EE 2700
Digital Circuits

Lab 4 – A 2-bit Comparitor

Objective: The student will design a combinational arithmetic circuit from a logic equation that compares two 2-bit binary numbers. The student will also construct the circuit and verify its operation.

Parts: 1-Proto board with switches and LEDs from Lab 1
1-74LS00 (Quad 2-input nand gate)
1-74LS10 (Triple 3-input nand gate)
1-74LS04 (Hex inverter, unnecessary if the 74LS00 is used for inverters)

Preparation: Write the title and a short description of this lab in your lab book. Make sure the page is numbered and make an entry in the table of contents for this lab.

Design a logic circuit to compare two 2-bit binary numbers A_1A_0 and B_1B_0 and determine if A<B. Assume the signals which represent A and B are active high (i.e. H = 1). Make the output A<B active high (H implies A<B, L implies A≥B). Use only NAND gates and inverters in the design (to reduce chip count, you may use a NAND gate as an inverter by connecting the other input(s) to Vcc). Note: The simplest SOP expression for A<B is:

$$A < B = \bar{A}_1 B_1 + \bar{A}_1 \bar{A}_0 B_0 + \bar{A}_0 B_1 B_0$$

Get a pin diagram for the 74LS10 and affix it to your lab book before coming to the lab. (You should already have pin diagrams for the 74LS00 and the 74LS04.) Pin diagrams are often shown in the data sheets, which can be found on the manufacturer's web site (e.g. http://www.ti.com, Look for logic devices) or at archive sites (e.g. www.datasheetcatalog.com). Since this part will be used again in later labs, many students affix the pin diagrams to the inside covers of their lab books for easy reference.

Draw your schematic in your lab book. Label each gate in your schematic with a designator (the letter U followed by a number to designate the IC and a letter to designate the gate within the IC). For example, The NAND gate that uses pins 4, 5 and 6 of U1 (which is a 74LS00) might be labeled U1B. Label all IC connections with a pin number. The pin number is placed above the wire near (but outside) the gate. Choose one gate from each IC and add power and ground connections. These connections are drawn vertically out of the gate, with power (Vcc) on the top and ground on the bottom. Add pin numbers to the left of the wires. You do not need to include the switches, resistors and the LEDs that you built in lab 1.

On the proto board, build the combinational logic circuit you designed. Be sure and connect Vcc (+5 Volts) and GND for each device on your proto board. Connect the inputs to the switches from lab 1 and the output to one of the inverters/LEDs from lab 1.

Assemble your circuit prior to your lab period.

Procedure: Connect Vcc and Ground to the fixed 5V output of the power supply. Verify the circuit operation by testing all 16 possible input combinations. Record your results. If any input combination fails, debug your circuit and correct the problem. Write a short summary of your results then sign and date it. Demonstrate to your lab instructor that the circuit functions correctly.

Signoff: A lab score can only be given if the circuit is functional.

Rubric (10 points total)

- Lab book is bound, clearly legible and in ink. (1 point)
- Lab book contains a clear title and a short description of the lab. (1 point)
- Lab book contains a schematic with chips and pins labeled (2 points)
- Lab book contains test results (1 point)
- Lab book has no obliterations. (1 point)
- Lab book contains a signed, dated summary (1 point)
- Each used page has a page number and is initialed* and dated* (1 point)
- The circuit is functional before the end of the lab period. (2 points)

Note: If the circuit is working at the end of the lab period but the lab book is not yet complete, the lab can be signed off as “working”, and no late penalty will be assessed if it is graded on or before the next lab period.

* It is not necessary to initial and date a page that contains a signature and date unless the dates are different.