EE 2700
Digital Circuits

Lab 5 – 1-bit Full Adder

Objective: In this lab, the student will use Karnaugh maps to design a one-bit full adder from a truth table. The one-bit full adder adds three one-bit numbers to form a 2-bit binary result. 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)
2-74LS10 (Triple 3-input nand gate)
1-74LS20 (Dual 4-input nand gate)
1-74LS04 (Hex inverter)

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.

A full adder is a device that adds three single bits to form a 2-bit binary number. This behavior can be illustrated by the truth table below.

Inputs			Outputs	
A	B	C	S_1	S_0
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Figure 1 – Truth Table for the Full Adder

Draw Karnaugh maps (in your lab book) for both S_1 and S_0. Reduce these maps and obtain a minimum SOP expression for each. (Hint. The sum-of-products expression for S_0 cannot be simplified, but the expression for S_1 can be.)

Design a digital circuit to implement the full adder. Assume all inputs and outputs are active high. Record the schematic for your circuit in your lab book.

Get a pin diagram for the 74LS20 and affix it to your lab book before coming to the lab. (You should already have pin diagrams for the 74LS00, 74LS04 and 74LS10.) Label each gate in your schematic with a designator and label each IC connection with a pin number. Remember to show power and ground connections. 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 outputs to the inverters/LEDs from lab 1.

Assemble your circuit prior to your lab period.

Procedure: Turn on the power supply and adjust it to 5 Volts. Carefully connect the positive (red) lead to the Vcc of your circuit and the negative (black) lead to the ground of your circuit.

Using the DIP switch, step through all 8 possible input combinations listed in Figure 1 and verify that the output is correct. Record the results of your test in your lab book.

If the circuit does not function correctly, you will have to debug it. Often the most effective way to do this is to set the inputs in such a way that the output is in error, then to measure the input voltages of the gate with the incorrect output. Assuming you understand the circuit, you will be able to determine which of these inputs is in error. Check the wiring of the errant input. If the wiring is correct and connects to the output of another gate, measure the inputs of that gate and repeat until you have located the error.

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 contains 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.