

EE 2700 Digital Circuits

Lab 3 – Missile Launch Controller

Objective: The student will design a simple combinational circuit that performs a simple logical function. The student will become more familiar with schematics and bread-boarding techniques. The student will also construct the circuit and verify its operation.

Parts: 1-Proto board with switches, 74LS04 and LEDs from Lab 1
1-74LS00 (Quad 2-input NAND gate)

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.

After watching “War Games” with Matthew Broderick, the military decides to put one senior launch officer and two junior launch officers in each missile silo. The missile should be launched when two of the three officers turn their keys, so long as one of them is the senior officer.

Your task is to design a circuit that generates the launch signal, L , given the three input signals: S (senior officer), $J1$ (first junior officer) and $J2$ (second junior officer). Assume S , $J1$ and $J2$ become high when their keys are turned and the missile is launched when L becomes high. (Don’t go there.)

Start with the verbal expression: “Launch the missile when either (a) the senior officer and the first junior officer both turn their keys, or (b) the senior officer and the second junior officer both turn their keys.”

Rewrite this expression using Boolean Algebra. Design a digital circuit using only NAND gates and inverters to implement this logic expression. (Hint: you shouldn’t need the inverters.)

Get a pin diagram for the 74LS00 and affix it to your lab book before coming to the lab. (You should already have a pin diagram for 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 (V_{cc}) 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.

Bring your notebook containing your schematic and pin diagrams to the lab. Also bring the necessary parts. Note: in future labs, you will be required to assemble your circuit on the proto-board before coming to lab, but not for this lab since you may need help making the connections on the proto-board the first time.

Procedure: On the proto board, build the combinational logic circuit you designed. Be sure and connect V_{cc} (+5 Volts) and GND for each device on your proto board. Connect the inputs (S , $J1$ and $J2$) to the switches from lab 1 and the output (L) to one of the inverters/LEDs from lab 1.

Connect V_{cc} and Ground to the fixed 5V output of the power supply. Verify the circuit operation by testing all 8 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.