EE2700
Digital Circuits

Lab 1 – Basic Digital Input / Output

Objective: The student should learn to produce digital signals using (single throw) switches and to display digital signals using LEDs. The student should also become more familiar with lab equipment and the prototype board.

Parts:
1 – Proto board (will be used for all labs)
1 – DIP switch (4 or more switches)
4 –10KΩ resistor (individual or in a resistor network)
4 – LEDs any color
4 – 2KΩ resistor (individual or in a resistor network)
1 – 74LS04

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.

Part 1. A typical circuit that uses a switch to create a digital signal is shown in Figure 1. Copy this schematic into your lab book. Predict whether the output will be high or low when the switch is open. Make a similar prediction for the time when the switch is closed.

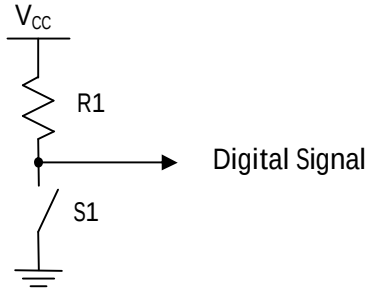

Figure 1. Using a Switch to Create a Digital Signal

Procedure: Using 10KΩ resistors and at least four switches (from the DIP switch), build circuitry (as shown in Figure 1) to create four separate digital signals you can control with a DIP switch. Turn on the power supply and adjust it to 5.0V for Vcc. (You may also use the fixed 5V supply.) Connect the black lead to ground and the red lead to Vcc. Using the Multimeter configured for DC Volts, measure the voltage on each of the 4 digital signals and verify they change from high (5V) to low (0V) or vice-versa when the switch is toggled. Demonstrate your working circuit to your lab instructor.

Make note in your log book whether the signal is high or low when the switch is open. Repeat for when the switch is closed. Do your observations match your predictions? Explain (in your lab book) why or why not.

Part 2. One way to display the state of a digital signal without a volt meter is to

use an LED. The circuit in Figure 2 shows one way to connect an LED to a digital circuit that works for most digital technologies (e.g. TTL).

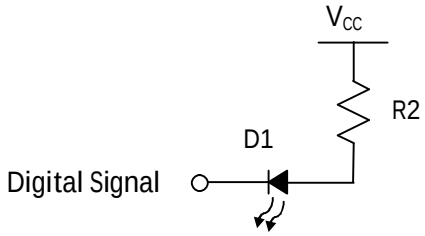

Figure 2. Digital Signal Driving an LED.

The confusing thing about this circuit is that the LED is on when the signal is *low*. Most people (particularly students) are more comfortable if the LED is on when the signal is *high*. In Chapter 1 of the text, we learned about a digital device called an inverter. An inverter outputs a high signal when its input is low and a low signal when its input is high. We can use an inverter get the more intuitive (on = high) behavior from the LED. (Figure 3):

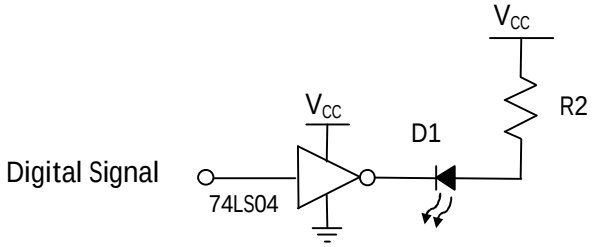

Figure 3. Positive Logic Digital Signal Driving an LED.

In this case, the inverter is a commercially available device called a 74LS04. It comes in a dual-in-line package (DIP) that has 14 pins or terminals. Pin numbers start at 1 just left of the notch on one end of the package and count up counter-clockwise (see Figure 4).

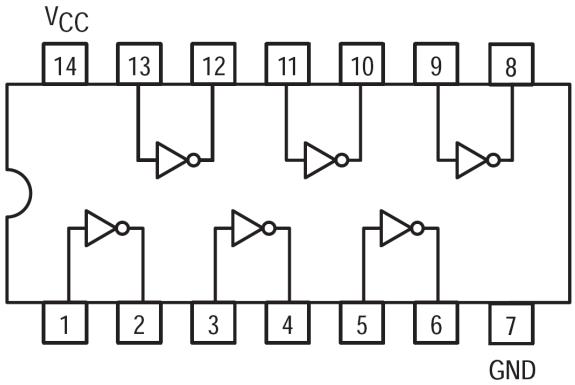

Figure 4. Pin Diagram of a 74LS04.

The 74LS04 has 2 pins for power (Vcc) and ground. These must be connected

for the 74LS04 to work correctly. For the 74LS04, Vcc should be 5.0V. If you apply more voltage than that, you will let the smoke out ☺ and destroy the 74LS04. You should already have a suitable 5-Volt Vcc from Part 1.

Procedure: Copy the circuit in Figure 3 into your lab book. Build four copies of the circuit in Figure 3 using four different inverters from the same 74LS04. For the LEDs that are provided, an R2 value of 2KΩ works well.

Connect the inputs of the inverters to the digital signals you created in Part 1. Verify that when each switch opens, its corresponding LED lights up. Demonstrate your working circuit to your lab instructor.

NOTE: Throughout the remainder of the semester, you will need digital signals to be the inputs and LEDs to display the outputs of the circuits you design. If you don't tear down the circuits you built in this lab, you will be able to use them over again for later laboratory exercises.

Write a short summary of your results then sign and date it. Then present your lab book to your lab instructor for grading.

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)
- Predictions and results are recorded in the lab book. (2 points)
- Lab book contains no obliterations (no white-out and nothing scribbled out or overwritten). (1 point)
- Lab book contains a signed, dated summary discussing the lab results. (1 point)
- Each used page has a page number. (1 point)
- Each used page 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.