

# Electronic Homework Assignment 1

## Constructing Test, Input/Output, and Combinational Circuits

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## 1 Introduction

The purpose of this lab is to construct the power supply and input/output circuits to be used throughout this course, and construct three example combinational circuits.

## 2 Materials

### 2.1 Supplies from University Bookstore

- Breadboard
- Wire Cutter/Stripper
- 22-Gauge Wire
- 4 D-Cell Batteries

In past semesters, the bookstore stocked only the breadboard and wire cutters. They have been asked to order wire and batteries; if the shipment does not arrive soon enough, you can get wire and batteries from Radio Shack as was done in past semesters.

The breadboard, wire cutters, and batteries together cost about \$50 (don't know how much wire costs until shipment arrives).

### 2.2 Supplies from ECE Parts Shop (Room 409 Daniels)

- 7805 Voltage Regulator
- 1  $1\mu\text{F}$  Capacitor

- 74LS05 Open Col. Hex Inv.
- 6 LEDs
- 6  $330\Omega$  Resistors
- 14  $1k\Omega$  Resistors
- 74LS04 Hex Inverter
- DIP Switch
- Battery Pack
- 2 74LS10 chips (3-input NAND gates)
- 1 74LS08 chip (2-input AND gates)
- 1 74LS32 chip (2-input OR gates)

### 3 What To Do

Build the circuits shown in Figures 1, 2/3, 4/5, 6/7, 8, 9, and 10. You will be expected to repeat the following tests for your lab instructor.

**Power Test:** Connect the battery pack to your power supply circuit on the breadboard. Verify that the battery pack is supplying 6v DC and that the output of the power supply circuit is 5v DC. Your instructor will assist you in performing this test.

**LED Test:** Connect the input of each LED buffer circuit to *Gnd* (the inputs are pins 1, 3, 5, 9, 11 and 13 of the 7405). The corresponding LED should be off. Connect the input of each LED buffer to *Vcc*. The corresponding LED should glow.

**DIP Switch Test:** Check all DIP switch sections one at a time by connecting an output of the DIP switch – between the resistor and the switch – to the input of an LED buffer. When the switch position is “on” the LED should be off. When the switch position is “off” the LED should glow.

**Logic Circuit Tests:** Verify that your 3 logic circuits produce the correct outputs for all input combinations (should match truth table). Use the DIP Switch Assembly to apply inputs to the logic circuits, and the LED Assembly to monitor the outputs of the logic circuits.

### 3.1 Power Supply Circuit

Figures 1, 2, and 3 contain the schematics for the power supply section. In Figure 1, you should be able to see a breadboard very similar to the one that you have. Notice the three posts on one side, one is black and the other two are red. Connect the black wire from your battery holder to the black post on your breadboard. Connect the red wire from the battery pack to the middle red post of your breadboard. Next, neatly add the wires that are highlighted in black in Figure 1. You should notice that the rows labeled X and Y in Figure 1 are ground rails, and the rows labeled W and Z are power rails. When a wire is inserted into a hole in the ground rail the boolean "value" of that wire is a 0. Likewise, when a wire is inserted into a power rail, that wire has a boolean "value" of 1. Make sure not to forget to connect the eight small wire in the middle of the breadboard. These wires connect the top of the breadboard to the bottom, and allow power and ground to be easily accessible from everywhere on the breadboard.

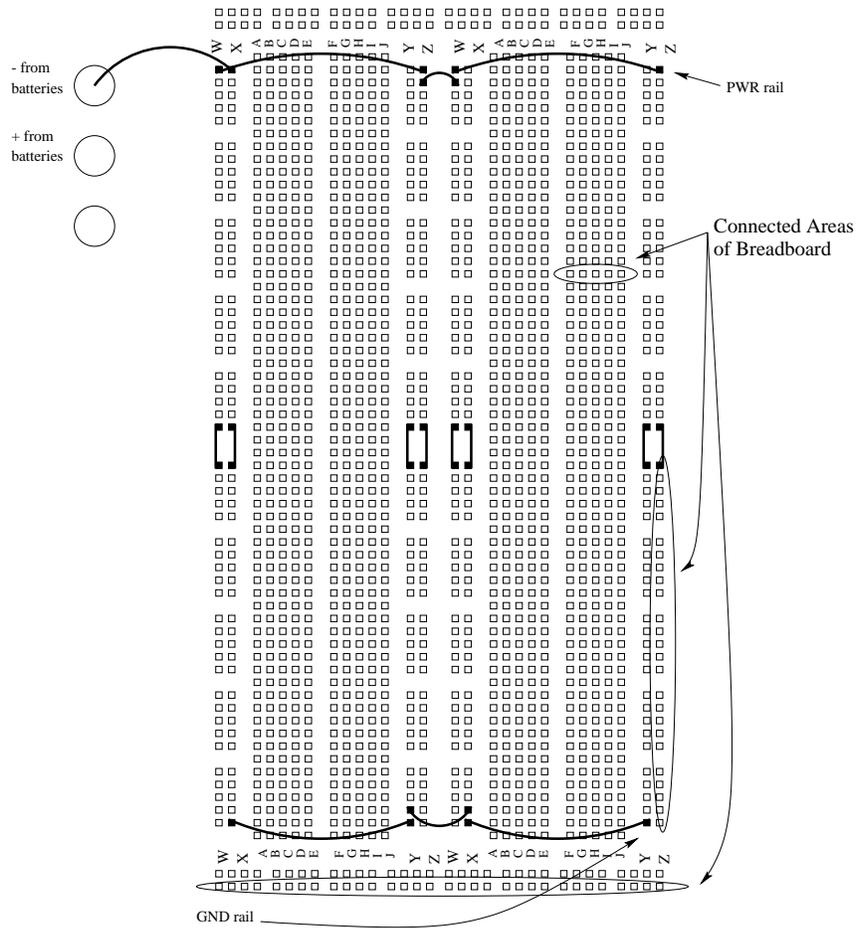


Figure 1: Power and Ground Rails

Next, the 7805 Voltage Regulator should be placed on the board. The voltage allows the six volts supplied from the batteries to be "regulated" to five volts, which is the appropriate voltage for the TTL chips that you will be using in this assignment. A circuit diagram of this is shown in Figure 2. You can see that the 4, 1.5 volt batteries are connected such that their sum adds up to 6 volts. Figure 2 also shows a physical drawing of the 7805. Note how the three legs of the voltage regulator are labeled.

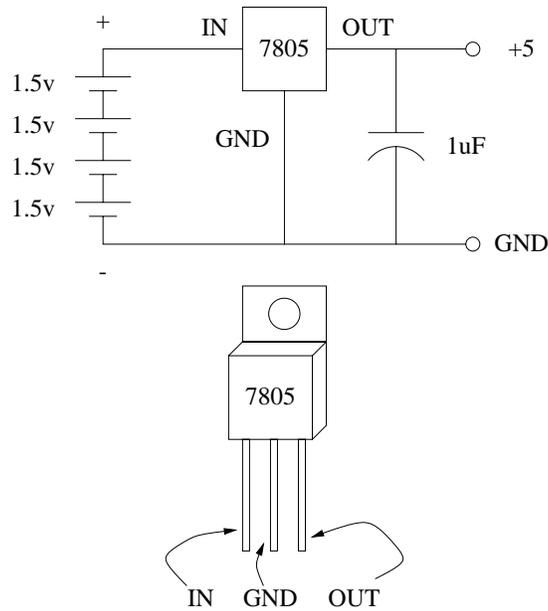


Figure 2: 7805 Voltage Regulator Diagrams

Finally, take a look at Figure 3. This figure shows you how to place and wire the 7805. This piece should go at the top of the breadboard closest to the pegs. Placing it here will facilitate providing power to your circuits. Note that the batteries + label goes to the middle red post on your board and the batteries - label indicates the black post on your board.

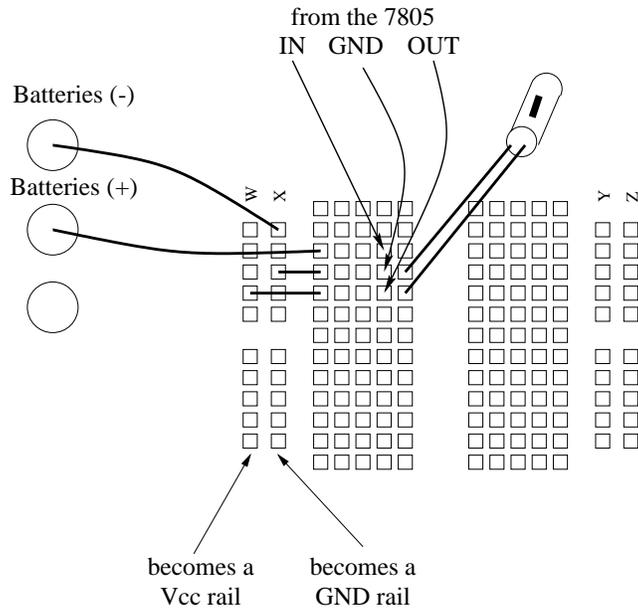


Figure 3: Layout of Voltage Regulator on Breadboard

### 3.2 Buffered LED Indicators

Now we will add LED's to the breadboard. These will allow us to "see" the output. If the LED is on, it indicates a boolean 1. If the LED is off, it indicates a boolean 0. Figure 4 contains the circuit diagram for the buffered LED indicators.

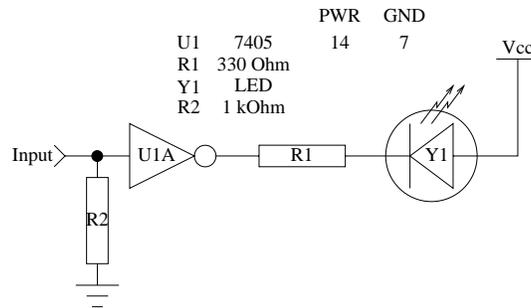


Figure 4: Buffered LED Indicators

Next, look at Figure 5. This will show you the layout for the LEDs. There is a TTL "chip" in the middle of the figure. This is a 74LS05, a hex inverter. The black boxes are resistors. The vertical ones have a value of 330 ohms and the horizontal ones have a value of 1k in Figure 5. The LEDs are the circles.

You must place the LED with the appropriate polarity or it will not work. The long lead of the LED must be wired to the power rails.

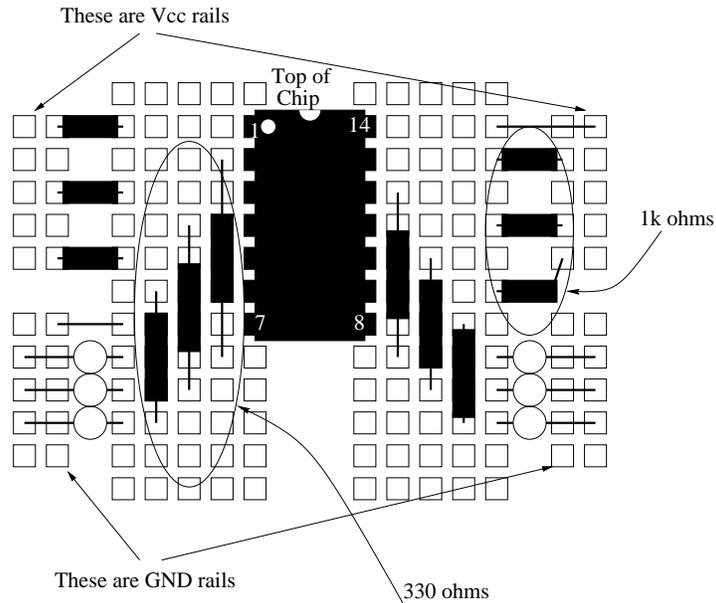


Figure 5: LED Setup on the Breadboard

The following table lists the input/output combinations for the 7405 inverter. Note that power is supplied to pin 14 and ground to pin 7.

IN	OUT
1	2
3	4
5	6
9	8
11	10
13	12

Table 1: Inverter Input/Output Pairs

### 3.3 Eight Section DIP Switch Assembly

Next, we need to add the DIP switch to the breadboard. The DIP switch will allow you to supply inputs to the circuits that will be built in future labs. Figure 6 contains the schematic for the DIP switch assembly. You should repeat the circuit in Figure 6 for each of the eight DIP segments. Note from Figure 6 that when the switch is closed ("ON"), the output will be 0; when the switch is open ("OFF"), the output will be 1.

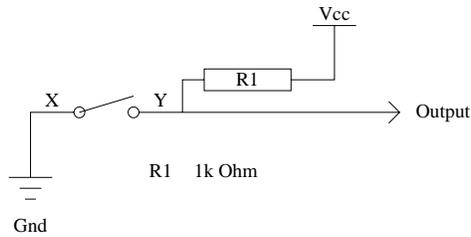


Figure 6: DIP Switch Circuit Diagram

Refer to Figure 7 for the breadboard layout of the DIP Switch Assembly.

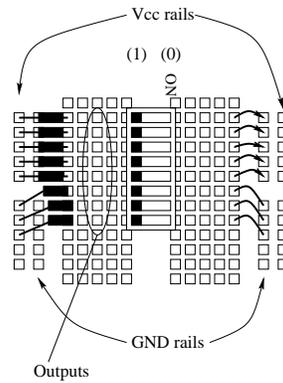


Figure 7: DIP Switch on Breadboard

### 3.4 Dual Rail Input Circuit

You should use your 7404 inverter to invert the inputs supplied from the DIP switch. Make sure that you wire pin 7 to ground and pin 14 to power. You will only be able to invert 6 of the 8 inputs on the DIP switch. The 7404 inverter has the same input/output pairs as the 7405, and the same power and ground pins.

## 4 Logic Circuits

You will build three separate logic circuits corresponding to the truth table in Table 2. Each circuit has three inputs (A2 A1 A0) and produces a single output (F0 produced by first circuit, F1 produced by second circuit, and F2 produced by third circuit).

A2	A1	A0	F2	F1	F0
0	0	0	0	1	1
0	0	1	0	0	1
0	1	0	0	0	0
0	1	1	1	0	0
1	0	0	0	1	0
1	0	1	1	1	0
1	1	0	1	1	1
1	1	1	0	1	1

Table 2: Truth Table.

#### 4.1 Reading the Schematic: IC Labels and Pin Numbering

The first integrated circuit (IC) in a schematic is labeled U1, the second IC is labeled U2, etc. Individual gates that are part of the same IC are distinguished by a letter, e.g., U1A, U1B, U1C, and U1D are four gates from the same IC (U1).

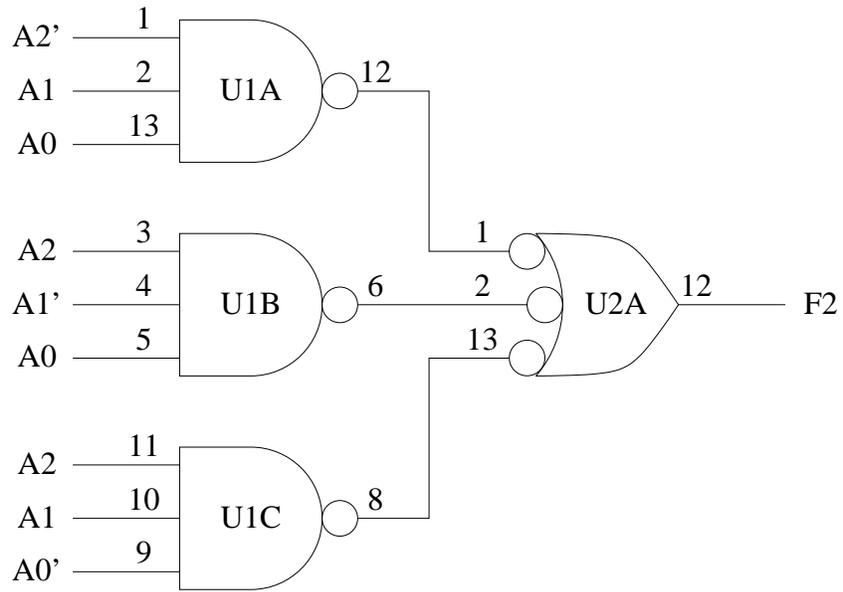
The inputs and outputs for each gate are labeled with their corresponding physical IC pin number. The legend with each schematic shows the pins that are connected to power and ground for each IC. This labeling structure makes it easy to debug circuits.

Note that a particular IC may contain more gates than are needed by a single circuit. The remaining gates may be used by the next circuit, avoiding extra unnecessary ICs on your breadboard. For example, only two ICs are used for building both circuit F1 and circuit F0, in Figures 9 and 10. That's because a single 7408 IC has enough AND gates for both circuits, and a single 7432 has enough OR gates for both circuits. The pin numbers in the schematics are labeled accordingly.

#### 4.2 Knowing which pins are which on an IC

You will have to know where pins 1 through 14 are on the 74xx chips. Pin 1 is usually marked by a small circle next to the pin (that end of the IC also has a semi-circle divet). You must look at the pinout diagrams of the 74xx chips to get used to where pins are. The TTL datasheets posted on the lab web page has these pinouts.

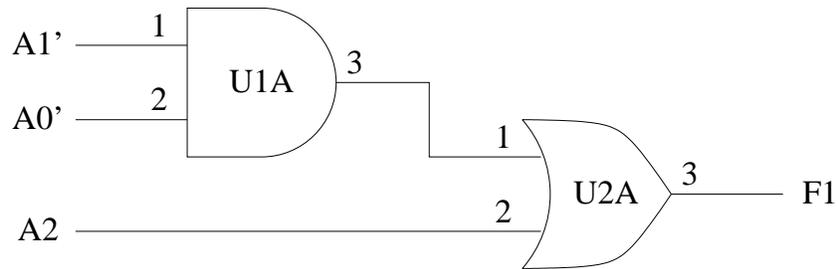
### 4.3 Circuit $F_2$



		PWR	GND
U1	7410	14	7
U2	7410	14	7

Figure 8: Circuit  $F_2$ .

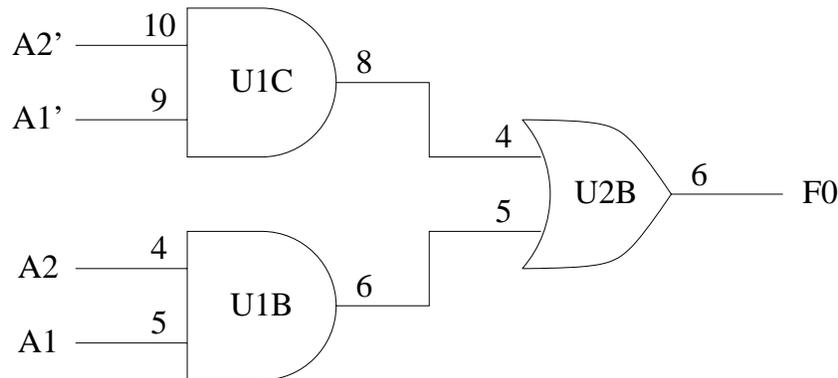
#### 4.4 Circuit $F_1$



		PWR	GND
U1	7408	14	7
U2	7432	14	7

Figure 9: Circuit  $F_1$ .

#### 4.5 Circuit $F_0$



		PWR	GND
U1	7408	14	7
U2	7432	14	7

Figure 10: Circuit  $F_0$ .

#### 4.6 Overall Framework

The framework for your lab is shown in Figure 11. Inputs generated by the DIP Switch Assembly (which generates both uncomplemented and complemented values of a signal) are applied to the logic circuits, and outputs are monitored

by connecting the circuit output to the LED Assembly. This is how you will test your logic circuits.

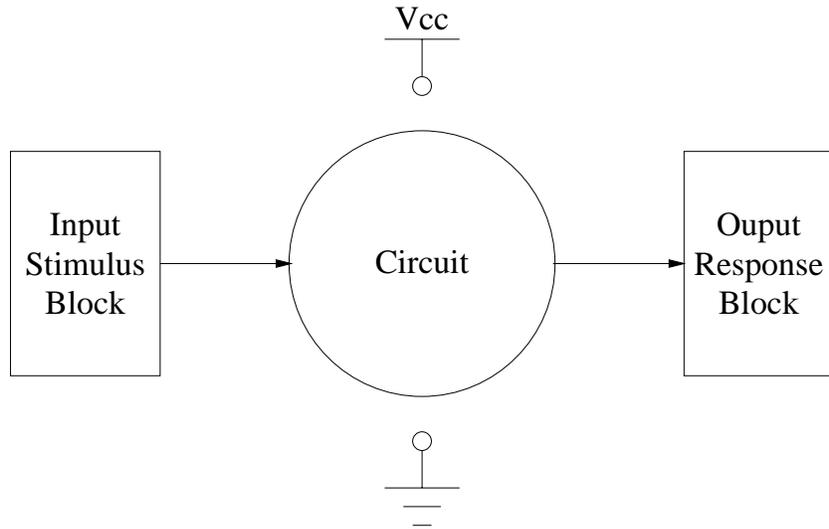


Figure 11: Lab framework.

## 5 Circuit Building Hints

- Each circuit should be as compact as possible. The remaining room on the breadboard will be utilized by future circuits. Try to use no more than 25% - 30% of the total board area for all of these circuits.
- Do not drive LEDs unless a resistor is connected in series with it (this limits the current through the LED and prevents it from burning out).
- The battery terminals (+/-) must be connected to the circuits. The positive terminal is connected to the  $V_{cc}$  power bus. Similarly, the negative terminal is connected to the  $Gnd$  bus.
- Watch that component wires (resistor leads and such) are not touching where they aren't supposed to be. This results in a short circuit.