

Name \_\_\_\_\_

## EET 131 Lab #1: Breadboard Introduction

### Equipment and Components

ETS-7000 Digital-Analog Training System  
Logic probe  
Resistors: 220  $\Omega$  (you'll need 7 of these)  
Integrated Circuits: Seven-segment display, 7490

### PART 1: Breadboarding Guidelines

The circuits that you'll build in this course are more complex than circuits that you built in EET 114. Also, most of the circuits in this course will involve dual inline packages (DIPs). Whenever you build a circuit in this course, I'll expect you to follow a set of guidelines posted on the course website (also at <http://people.sinclair.edu/nickreeder/eet131/breadboardingTips.htm>.)

Before going any further in this lab, carefully study this set of guidelines, which cover the following topics:

- Straightening a Bent Pin
- Inserting a DIP
- Using Power and Ground Busses
- Wire Colors
- Wire Lengths
- Straightening and Trimming Wire Ends
- Providing Access to the DIP
- Removing a DIP

Your grade on this lab (and on other labs in this course) will depend on how well you follow these guidelines, in addition to whether or not your circuit works correctly.

### PART 2: Some New Trainer Features

In this lab (and in many of the labs ahead) you'll use some features of the trainer that you may not have used before.

- **Fixed 5-Volt Power Supply.** This power supply, labeled +5V, always produces a voltage of 5 V. In EET 114 you mostly used the variable power supply, labeled 0~+15V, which can be adjusted to any voltage between 0 V and 15 V. **Digital circuits should always be powered from the fixed 5 V supply, not from the variable supply.** Connecting a DIP to voltages greater than 5 V can ruin the DIP.
- **Data Switches.** The trainer has eight data switches, labeled SW0 through SW7. Each switch has two possible positions, up and down. Notice the other labels on the trainer: the "down" position is labeled 0, and the "up" position is labeled 1. Let's use the logic probe to investigate the behavior of a data switch.
  1. **With the trainer's power turned off**, use a short red wire to connect the logic probe's red clip to +5V on the trainer. Also, use a short black wire to connect the logic probe's black clip to Ground (GND) on the trainer.
  2. Turn the trainer's power on.

3. With the trainer's data switch SW0 set to the "down" position, touch the logic probe's tip to SW0's terminal. The logic should probe indicate either a HIGH or a LOW. Which one does it indicate?

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4. While still touching the logic probe's tip to SW0's terminal, flip the switch to the "up" position. Which level does the logic probe indicate now (HIGH or LOW)?

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5. Use the logic probe to examine the other seven data switches' terminals as you flip each switch from "down" to "up." You should find that they all behave as SW0 did above.

- **Pulse Switches.** The trainer also has two pulse switches, labeled  $P_A$  and  $P_B$ . These switches are pushbuttons that return to their original position when you release them. Each pulse switch has two terminals:

- Switch  $P_A$ 's terminals are labeled  $A$  and  $\bar{A}$ .
- Switch  $P_B$ 's terminals are labeled  $B$  and  $\bar{B}$ .

Let's use the logic probe to investigate the behavior of a pulse switch.

6. While **not** pressing pulse switch  $P_A$ , touch the logic probe's tip to the  $A$  terminal and then to the  $\bar{A}$  terminal. In the first row of the table below, record the logic levels that you observe. Write L for low or H for high.

7. Next, repeat your observations while pressing pulse switch  $P_A$ . Record your observations in the table.

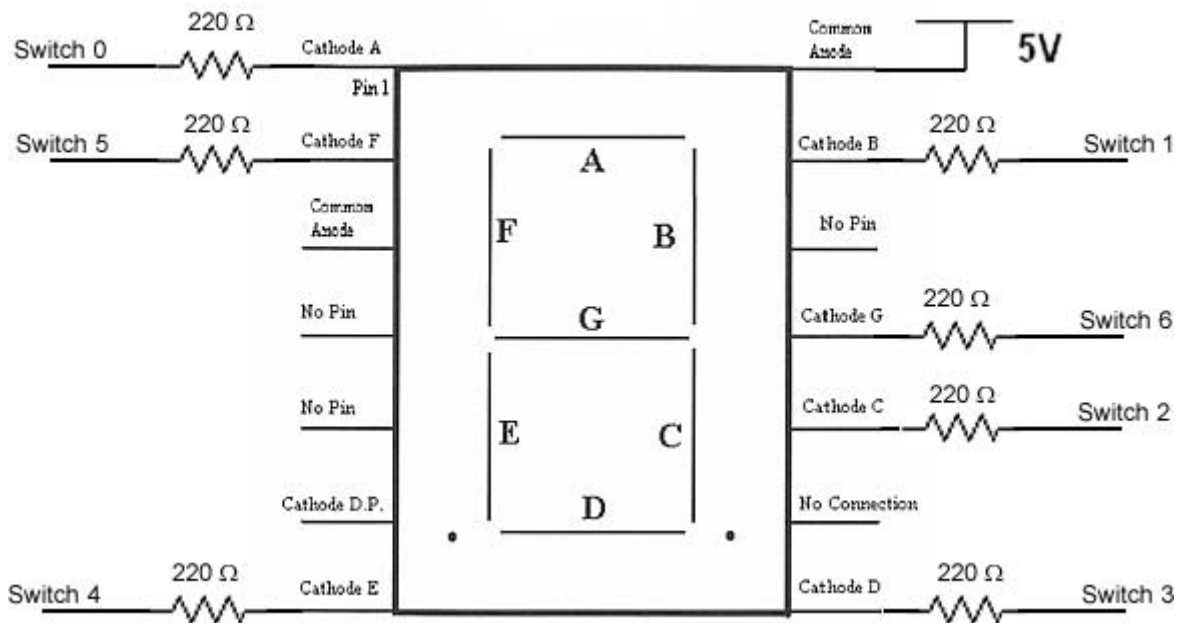
|                                 | Terminal $A$ | Terminal $\bar{A}$ |
|---------------------------------|--------------|--------------------|
| While not pressing switch $P_A$ |              |                    |
| While pressing switch $P_A$     |              |                    |

8. Use the logic probe to examine pulse switch  $P_B$ 's terminals while you press and release the switch. You should find that they behave as  $P_A$ 's terminals did above.

### PART 3: Seven-Segment Display

You've probably seen seven-segment displays on calculators, clocks, stereos, and many other devices. A seven-segment display has seven LEDs, labeled A through G, that can be lit up individually to form various numerals and letters.

1. **With the trainer's power turned off**, insert the seven-segment display into the breadboard so that none of its pins are connected to each other.
2. Using a red wire, connect the trainer's +5 V terminal to a power bus. Using another red wire, connect the power bus to the seven-segment display's "Common Anode" pin, as shown below.
3. Build the circuit shown below. Note that we're connecting seven of the trainer's data switches (SW0 through SW6) to the pins labeled "Cathode A" through "Cathode G" on the seven-segment display. But we're not connecting the switches directly to the pins—instead, there's a 220 Ω resistor between each pin and its switch.



4. Turn on the trainer's power. Observe how each switch controls one of the segments on the display. Make sure that each switch controls the segment listed next to it in the table below.

| Switch | Segment |
|--------|---------|
| SW0    | A       |
| SW1    | B       |
| SW2    | C       |
| SW3    | D       |
| SW4    | E       |
| SW5    | F       |
| SW6    | G       |

5. **Question:** To light up segment A, should switch SW0 be set to 0 or to 1? \_\_\_\_\_

6. **Question:** Suppose you want to display the numeral 3 on the display. Which of the display's segments should be lit up?

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7. Determine the switch settings that will cause the display to show each of the numerals and letters listed in the table below. In each row of the table, indicate the switch settings (0 or 1 for each switch) that cause the display to show that numeral or letter.

| Display  | SW6 | SW5 | SW4 | SW3 | SW2 | SW1 | SW0 |
|----------|-----|-----|-----|-----|-----|-----|-----|
| <b>0</b> |     |     |     |     |     |     |     |
| <b>1</b> |     |     |     |     |     |     |     |
| <b>2</b> |     |     |     |     |     |     |     |
| <b>3</b> |     |     |     |     |     |     |     |
| <b>4</b> |     |     |     |     |     |     |     |
| <b>5</b> |     |     |     |     |     |     |     |
| <b>6</b> |     |     |     |     |     |     |     |
| <b>7</b> |     |     |     |     |     |     |     |
| <b>8</b> |     |     |     |     |     |     |     |
| <b>9</b> |     |     |     |     |     |     |     |
| <b>A</b> |     |     |     |     |     |     |     |
| <b>b</b> |     |     |     |     |     |     |     |
| <b>C</b> |     |     |     |     |     |     |     |
| <b>d</b> |     |     |     |     |     |     |     |
| <b>E</b> |     |     |     |     |     |     |     |
| <b>F</b> |     |     |     |     |     |     |     |

8. When you're finished, ask me to check your table and your circuit. Remember, I'll be checking you not only on whether your circuit works correctly, but also on how well you followed the breadboarding guidelines.

Circuit works correctly? \_\_\_\_\_

DIP inserted correctly? \_\_\_\_\_

Using power bus? \_\_\_\_\_

Wire colors? \_\_\_\_\_

Wire lengths? \_\_\_\_\_

Wire ends trimmed? \_\_\_\_\_

DIP accessible? \_\_\_\_\_

9. You're finished with this circuit and can take it apart.

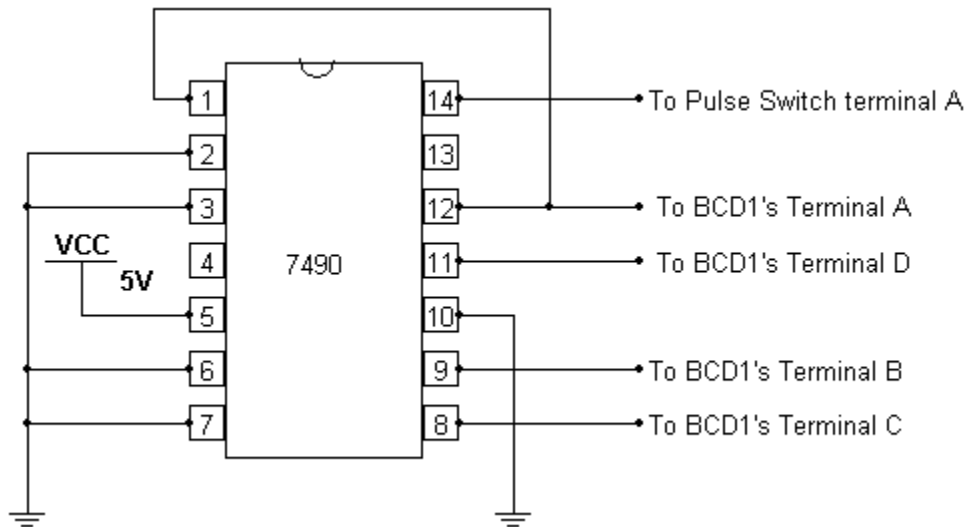
#### PART 4: A Circuit Using the Trainer's Built-in Seven-Segment Display

Our trainer contains two built-in seven-segment displays. They're located on the right hand side of the front panel in the area labeled "Digital Displays." They're easy to use because the seven resistors are also built into the trainer (underneath the cover), so you don't have to worry about placing and wiring the resistors.

Notice that each of the built-in seven-segment displays has four terminals, labeled A, B, C, and D. To use the displays in a circuit, you'll run wires from your circuit to these terminals.

Let's build a simple circuit that uses one of these seven-segment displays. For this circuit we'll use one of these displays, so we'll just run wires to the terminal group called BCD1.

1. **With the trainer's power turned off**, build the circuit shown below, using a 7490 chip. Note the following:
  - a. In this diagram, when two wires cross each other, they're not connected unless there is a junction (a dot) at the intersection. For example, the wire connecting pin 12 to pin 1 is not connected to the wire from pin 14. And the wires from pins 8 and 9 are not connected to the wire from pin 10.
  - b. Pins 2, 3, 6, 7, and 10 are connected to your ground bus.
  - c. Pin 5 is connected to your power bus.



2. Turn the trainer's power on. The built-in seven-segment display should display a number (probably 0, but possibly another number). If it doesn't, then your circuit is not built correctly, so you should turn off the power and re-check your wiring.
3. Press and release the trainer's Pulse Switch  $P_A$ . The number on the seven-segment display should increase by 1. Repeatedly press and release the pulse switch. Each time you release it, the displayed number should increase by 1 up to 9, after which it should go back to 0.
4. When your circuit works correctly, ask me to check it.  
Circuit works correctly? \_\_\_\_\_ DIP inserted correctly? \_\_\_\_\_  
Using power/ground busses? \_\_\_\_\_ Wire colors? \_\_\_\_\_  
Wire lengths? \_\_\_\_\_ Wire ends trimmed? \_\_\_\_\_ DIP accessible? \_\_\_\_\_

5. Use the logic probe to examine the logic levels on the chip's pins 11, 8, 9, and 12 for each value displayed on the seven-segment display. For each value displayed on the seven-segment display, record whether there's a low level or a high level on each pin. Write L for low and H for high.

| Value Displayed | Level on Pin 11 | Level on Pin 8 | Level on Pin 9 | Level on Pin 12 |
|-----------------|-----------------|----------------|----------------|-----------------|
| 0               |                 |                |                |                 |
| 1               |                 |                |                |                 |
| 2               |                 |                |                |                 |
| 3               |                 |                |                |                 |
| 4               |                 |                |                |                 |
| 5               |                 |                |                |                 |
| 6               |                 |                |                |                 |
| 7               |                 |                |                |                 |
| 8               |                 |                |                |                 |
| 9               |                 |                |                |                 |

6. You should notice some patterns in the data you recorded. In particular:
- What pattern do you see on pin 12 going down the rows of the table?
  
  - What pattern do you see on pin 9 going down the rows of the table?
  
  - What pattern do you see on pin 8 going down the rows of the table?

**PART 5: Review.** For the seven-segment display circuit that you built, indicate how you would set the switches (0 or 1 for each switch) to display each letter listed in the table below. **You don't need to build the circuit again.** You should be able to answer by studying your previous results.

| Display  | SW6 | SW5 | SW4 | SW3 | SW2 | SW1 | SW0 |
|----------|-----|-----|-----|-----|-----|-----|-----|
| <b>H</b> |     |     |     |     |     |     |     |
| <b>L</b> |     |     |     |     |     |     |     |
| <b>P</b> |     |     |     |     |     |     |     |
| <b>U</b> |     |     |     |     |     |     |     |