

Name _____

EET 251 Lab #3

Multiplexers and Demultiplexers

Equipment and Components

ETS-7000 Digital-Analog Training System
Integrated Circuits: 7493, 74138, 74151

Breadboarding Guidelines

First, review the breadboarding guidelines posted on the course website (also at <http://people.sinclair.edu/nickreeder/eet131/breadboardingTips.htm>.) Remember, your grade will depend on how well you follow these guidelines, in addition to whether your circuit works correctly.

Reminder About Unused Pins

In the circuits that we build today and throughout the rest of this course, you will sometimes have unused input or output pins on a digital chip.

- For proper operation, **an unused input pin should be tied to its inactive level.** Tie it low if the pin is active-high. Tie it high through a 1-k Ω resistor if the pin is active-low.
- But an **unused output pin should be left floating, and should never be tied high or low**—tying output pins high or low can burn out the chip.

Multiplexers

1. The first sentence in Section 6-8 of your textbook defines the word **multiplexer**. Copy this sentence below and make sure you understand what it means.

A **multiplexer (MUX)** is

2. Using a copy of the “TTL Data Book” or Texas Instruments’ website (<http://www.ti.com>), find the datasheets for the following chips:
 - 74151
 - 74153
 - 74157

According to the headings in the upper corner of your datasheets, what kind of circuits are on these chips?

74151 _____

74153 _____

74157 _____

74151 Multiplexer

1. Using a straight edge, copy the 74151's pin diagram and logic symbol in the space below. Be sure to include each pin's name and number. Also be sure to include any markings that indicate active-low inputs or outputs.

74151 pin diagram

74151 logic symbol

2. Use the 74151's logic symbol to answer the following questions:

How many **input** pins does a 74151 have? _____

Which one of the following statements is true?

- All of the 74151's inputs are active-high.
- All of the 74151's inputs are active-low.
- Some of the 74151's inputs are active-high, and some are active-low.

How many **output** pins does a 74151 have? _____

Which one of the following statements is true?

- All of the 74151's outputs are active-high.
- All of the 74151's outputs are active-low.
- Some of the 74151's outputs are active-high, and some are active-low.

Demultiplexers

1. The first two sentences in Section 6-9 of your textbook define the word **demultiplexer**. Copy these two sentences below and make sure you understand what they mean.

A **demultiplexer (DEMUX)**

2. Using www.ti.com or the TTL Data Book, find the datasheets for the following chips:
 - 74138
 - 74139
 - 74154

According to the headings in the upper corner of your datasheets, what kind of circuits are on these chips?

74138 _____

74139 _____

74154 _____

74138 Demultiplexer

1. Using a straight edge, in the space below, copy the 74138's pin diagram and its **logic symbol when used as a demultiplexer (not as a decoder)**. Be sure to include each pin's name and number. Also be sure to include any markings that indicate active-low inputs or outputs.

74138 pin diagram

74138 logic symbol

2. Use the 74138's logic symbol to answer the following questions:

How many **input** pins does a 74138 have? _____

Which one of the following statements is true?

- All of the 74138's inputs are active-high.
- All of the 74138's inputs are active-low.
- Some of the 74138's inputs are active-high, and some are active-low.

How many **output** pins does a 74138 have? _____

Which one of the following statements is true?

- All of the 74138's outputs are active-high.
- All of the 74138's outputs are active-low.
- Some of the 74138's outputs are active-high, and some are active-low.

Multiplexer/Demultiplexer Circuit

1. Study the schematic diagram on the following page. It shows a circuit containing three ICs:
 - a 7493 counter (which we'll study in a few weeks)
 - a 74151 multiplexer (MUX)
 - a 74138 demultiplexer (DEMUX)

The circuit also contains:

- a square wave generator
- seven switches (three to control the MUX, and four to control the DEMUX)
- eight LEDs.

Here's how the circuit works:

- The square wave generator produces a 16 Hz square wave that drives the counter.
- The counter then produces:
 - an 8 Hz square wave at its pin 12
 - a 4 Hz square wave at its pin 9
 - a 2 Hz square wave at its pin 8
 - a 1 Hz square wave at its pin 11.
- The five square waves of different frequencies become the MUX's data inputs. Switches 7, 6, and 5 then select one of these five square waves, which is passed to the MUX's output pin and transmitted to the DEMUX.
- Switch 0 enables or disables the DEMUX.
- If the DEMUX is enabled, then Switches 3, 2, and 1 select one of the DEMUX's outputs, passing the square wave from the DEMUX to one of the LEDs.

For example, suppose switches 7, 6, and 5 are all switched OFF. Then the MUX will select the 16 Hz waveform and send it to the DEMUX. Suppose also that switches 3, 2, 1, and 0 are all switched OFF. Then the DEMUX is enabled and sends the waveform to LED 0, which will blink at a rate of 16 Hz. The other LEDs will all stay lit constantly.

2. To test your understanding of the circuit, fill in the blanks below. Suppose the switches are set as follows:

Switch 7: OFF Switch 6: ON Switch 5: ON
Switch 3: ON Switch 2: OFF Switch 1: ON Switch 0: OFF

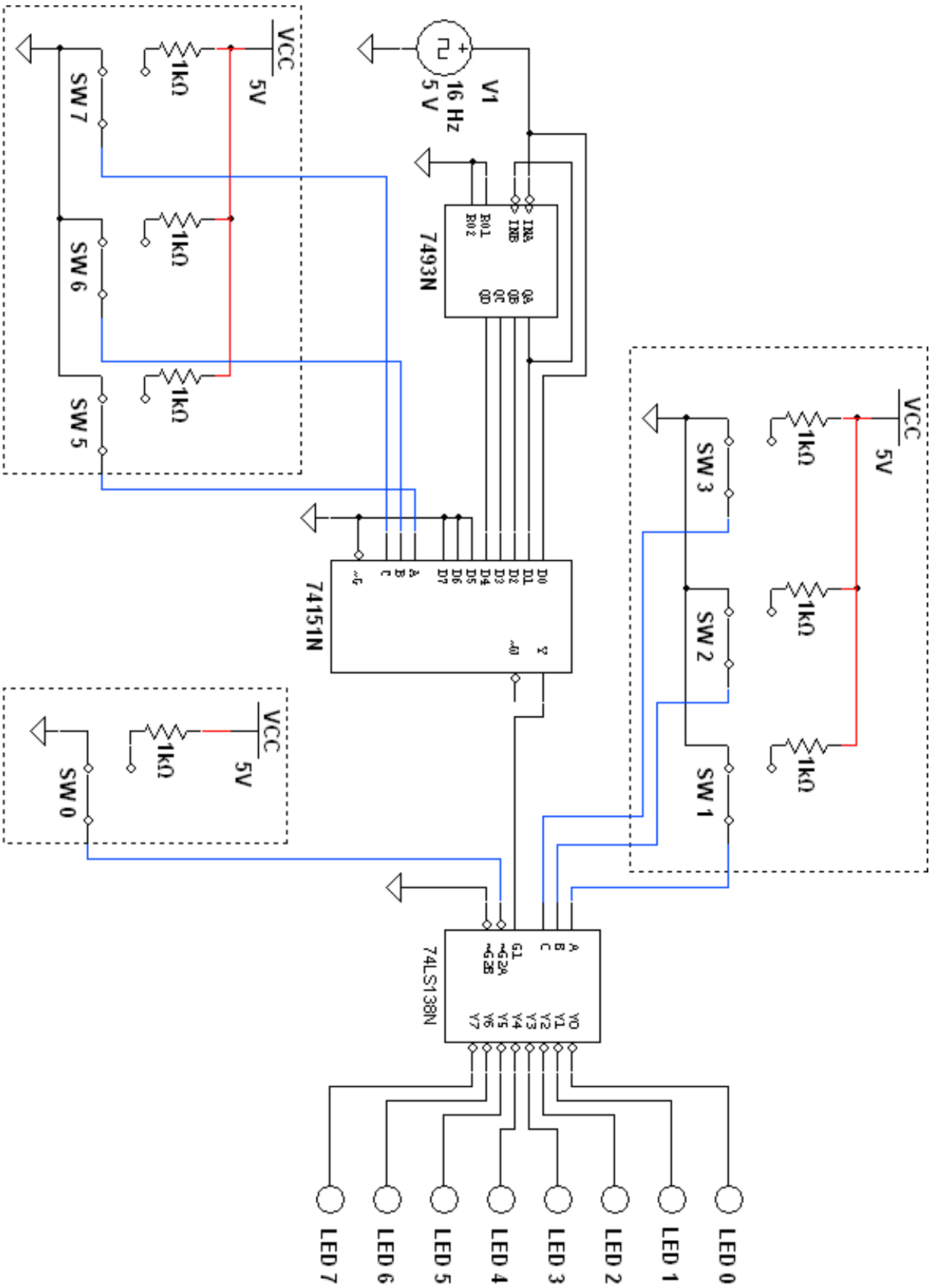
Then LED _____ will blink at a rate of _____ Hz.

3. Now suppose you want to make LED 1 flash at a rate of 8 Hz. How should you set the switches? (For each switch, write ON or OFF)

Switch 7: _____ Switch 6: _____ Switch 5: _____

Switch 3: _____ Switch 2: _____ Switch 1: _____ Switch 0: _____

4. **Build the circuit in Multisim.** Multisim does not run at real-time speed, so the LEDs won't flash at the expected frequencies (16 Hz, 8 Hz, 4 Hz, 2 Hz, or 1 Hz). But they will flash faster or slower depending on the settings of switches 7, 6, and 5.
5. Test your Multisim circuit by checking all possible switch combinations. When you're sure that it works correctly, ask me to check it.



Note: The dotted boxes around the switches indicate that the associated resistors and power/ground connections are internal to the trainer. When you breadboard, you do not need to place these resistors or make these connections.

6. **Build the circuit on the breadboard.** Note the following:
- The schematic diagram does not show power and ground pins, but of course you must connect these pins on the breadboard. **Don't assume you know which pins should be connected to power and ground—check the datasheets.**
 - Lay your chips out from left to right in the same order that they appear in the schematic diagram, and be sure to leave enough space between the chips so that you can pass wires between them.
 - Use the function generator's TTL MODE to generate the square wave. Using the Fluke 45 as a frequency counter, adjust your frequency to 16 Hz.
 - Use the same numbering on the switches and LEDs that I used in the schematic diagram.
7. Test your breadboarded circuit by checking all possible switch combinations. When you're sure that it works correctly, ask me to check it.

Circuit works? _____ DIPs inserted correctly? _____ Using power bus? _____

Wire colors? _____ Wire lengths? _____ Wire ends trimmed? _____

DIPs accessible? _____

Questions

1. On the 74151 chip, why is pin 7 tied to ground?
2. On the 74151 chip, why are pins 12, 13, and 14 tied to ground?
3. On the 74138 chip, why is pin 5 tied to ground?
4. On the 7493 chip, why is pin 10 tied to ground?

Review Questions

Match each type of chip with its function by filling in each blank with the correct number.

- | | | |
|------------------|-------|---|
| 1. Decoder | _____ | Accepts an active level on one of its inputs representing a digit and converts it to a coded output. |
| 2. Demultiplexer | | |
| 3. Encoder | | |
| 4. Multiplexer | _____ | Allows information from several sources to be routed onto a single line for transmission over that line to a common destination. |
| | _____ | Detects the presence of a specified combination of bits on its inputs and indicates the presence of that combination by a specified output level. |
| | _____ | Takes digital information from one line and distributes it to a given number of output lines. |

Match each chip number with its description by filling in each blank with the correct letter.

- | | | |
|------------|-------|---|
| A. 74150 | _____ | 8-line to 1-line data selector/multiplexer |
| B. 74138 | | |
| C. 74LS280 | _____ | 4-line to 16-line decoder/demultiplexer |
| D. 7447 | | |
| E. 74283 | _____ | 4-bit magnitude comparator |
| F. 74139 | | |
| G. 7485 | _____ | 16-line to 1-line data selector/multiplexer |
| H. 74154 | | |
| I. 74147 | _____ | 8-line to 3-line priority encoder |
| J. 74153 | | |
| K. 7442 | _____ | Dual 2-line to 4-line decoder/demultiplexer |
| L. 74151 | | |
| M. 74157 | _____ | 9-bit odd/even parity generator/checker |
| N. 74148 | _____ | Dual 4-line to 1-line data selector/multiplexer |
| | _____ | 4-line BCD to 10-line decimal decoder |
| | _____ | 4-bit binary full adder with fast carry |
| | _____ | BCD-to-seven-segment decoder/driver |
| | _____ | 10-line to 4-line priority encoder |
| | _____ | Quad 2-line to 1-line data selector/multiplexer |
| | _____ | 3-line to 8-line decoder/demultiplexer |

EET POST-LAB CHECKOUT

To be completed before leaving each lab session. Turn in the completed checklist with your lab report.

NAME _____ DATE _____ BENCH # _____

COURSE # _____ LAB # _____

Complete the following tasks and leave your workbench clean, safe, and neat before leaving the lab for the day.

Check	Lab Closeout Activity
	All equipment turned OFF.
	All lab power supply voltage and current controls set to minimum, including those on the trainer.
	DMM red test leads connected to voltage/resistance ports.
	All test leads loosely coiled and stowed. No dangling or tangled leads!
	Faulty or defective equipment reported to instructor.
	All components/jumpers removed from breadboard and stored properly in drawers, etc., not left on shelves in parts cabinet.
	Floor around your bench clear of dropped parts.
	Tools returned to storage box or drawer.
	Tool box properly closed and stowed on bench or in drawer.
	Instruments moved to back of bench or shelf, leaving clear workspace at the front of the bench.
	Borrowed parts and equipment returned.
	Personal items removed from bench: calculators, books, pens, papers, etc.
	Flash drive removed from computer.
	Trash placed in wastebasket.

Thank you!