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 on labs will depend on how well you follow these guidelines, in addition to whether or not your circuit works correctly.

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. In the space below, copy the 74151's pin diagram and logic symbol. 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 a copy of the "TTL Data Book" or Texas Instruments' website (http://www.ti.com), 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. 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.

Mutliplexer/Demultiplexer Circuit

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

   It also uses:
   - a square wave generator
   - five switches (two to control the multiplexer's input, and three to control the demultiplexer's output)
   - eight LEDs.

   Here is 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 four output waveforms from the counter become the multiplexer's four data inputs. Switches 7 and 6 then select one of these four waveforms, which is passed to the multiplexer's output and transmitted to the demultiplexer.
   - Switches 2, 1, and 0 then select one of the demultiplexer's pins as its active output, passing on the waveform from the demultiplexer to one of the LEDs.

   For example, suppose switches 7 and 6 are both switched ON. Then the multiplexer will select the 1 Hz waveform and send it to the demultiplexer. Suppose also that switches 2, 1, and 0 are all switched OFF. Then the demultiplexer will send the waveform to LED 0, which will blink at a rate of 1 Hz. The other LEDs will all stay lit constantly.

2. To test your understanding of the circuit, fill in the blanks. If switch 7 is OFF and switch 6 is ON, then the multiplexer will select the _____ Hz waveform and send it to the demultiplexer. Also, if switch 2 is OFF, and switch 1 is ON, and switch 0 is ON, then the demultiplexer will send the waveform to LED _____, which 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)

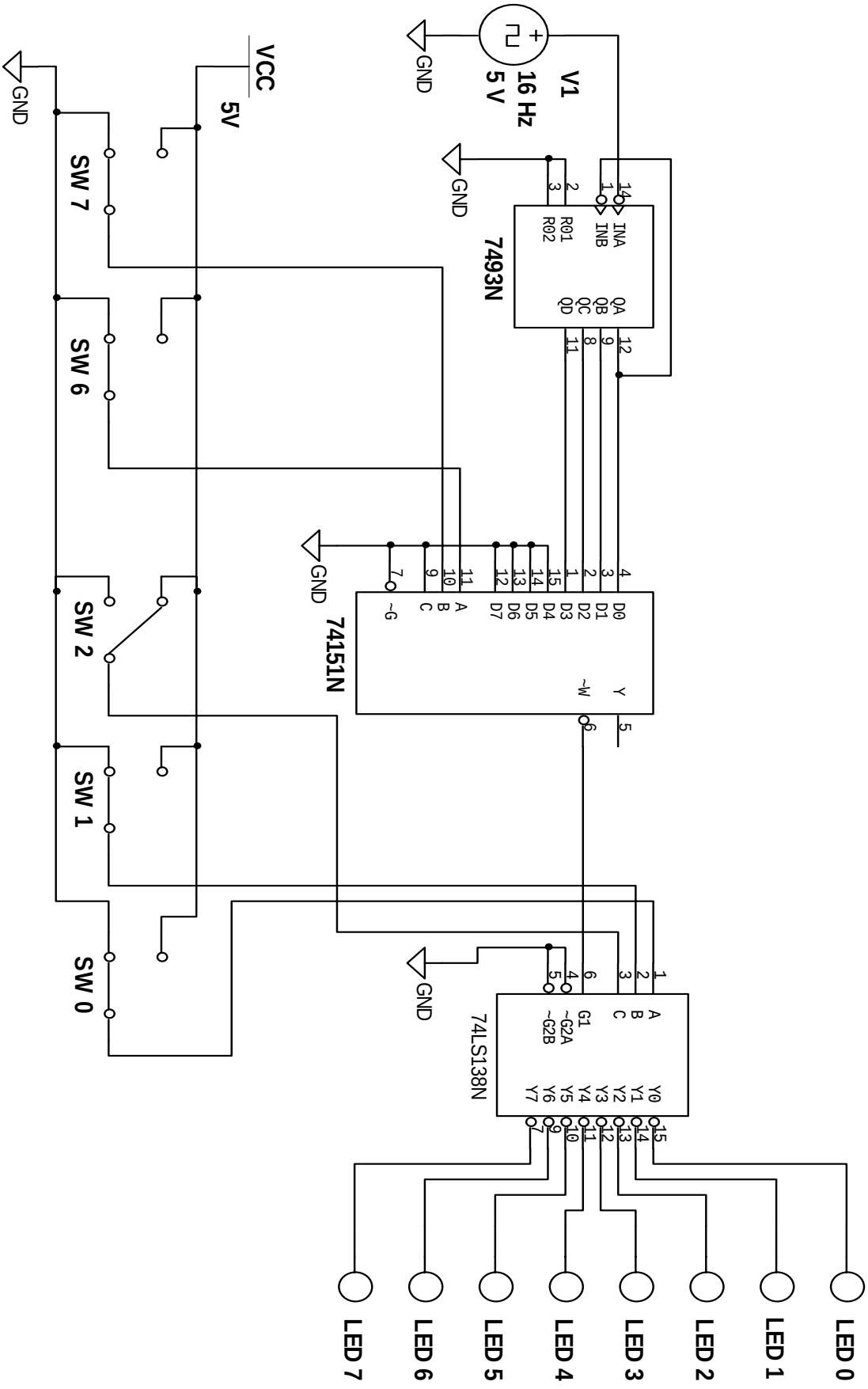
   Switch 7: _____

   Switch 6: _____

   Switch 2: _____

   Switch 1: _____

   Switch 0: _____


GND
V1
16 Hz
5 V
GND
7493N
INA
INB
R01
R02
QA
QB
QC
QD
VCC
5V
GND
SW 7
SW 6
SW 2
SW 1
SW 0
GND
74151N
D0
D1
D2
D3
D4
D5
D6
D7
A
B
C
~G
Y
~W
GND
74LS138N
A
B
C
G1
~G2A
~G2B
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
LED 0
LED 1
LED 2
LED 3
LED 4
LED 5
LED 6
LED 7

4. Build the circuit in Multisim. Note the following:
    - Multisim does not run at real-time speed, so the LEDs won't flash at the expected frequencies (8 Hz, 4 Hz, 2 Hz, or 1 Hz). But they will flash faster or slower depending on the settings of switches 7 and 6.

5. Test your Multisim circuit by checking all possible switch combinations. When you're sure that it works correctly, ask me to check it.

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6. Build the circuit on the breadboard. Note the following:
    - 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.
    - Use the same numbering on the switches and LEDs that I used in the schematic diagram.
    - 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.**

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? _____

Review Questions

1. On the 74151 chip, why is pin 7 tied to ground?

2. On the 74151 chip, why is pin 9 tied to ground?

3. On the 74151 chip, why are pins 12, 13, 14, and 15 tied to ground?

4. On the 74138 chip, why are pins 4 and 5 tied to ground?