W4B:DE 2.3.3 [Multisim] Multiplexers and De-Multiplexers

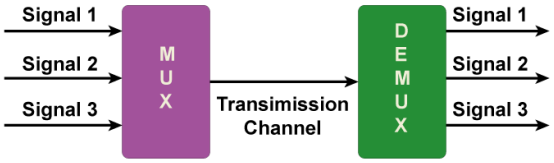
Introduction

Though it may be hard to believe, there was once a time when there was no more than one phone per household. That's right, just one. How was this phone connected to all of the other phones in your town or country? Obviously, it isn't practical to have a wire from your phone connected directly to all other phones individually. This would require an unimaginable amount of wire traveling to and from every home in America. The solution to this problem is for a group of homes to share one wire with another group of homes. This sharing of a resource, and in this case, the wire is a classic application of a **multiplexer/demultiplexer** circuit.

Another classic application of multiplexing/de-multiplexing is the way that **seven-segment display** signs are wired. In this activity you will implement two simple display signs. The first will not take advantage of multiplexing and the second will.

Multiplexing

Emile Baudot With multiplexing, multiple signals can be sent over one shared medium, such as a wire. Invented in the 1870s for communication by electric telegraph, multiplexing allowed two separate messages to travel in opposite directions simultaneously. It was later used in telephone systems with telephone operators manually creating the connection between the source caller and their desired destination.



Multiplexer and Demultiplexer

Fig 1 a) Mux/Demux devices

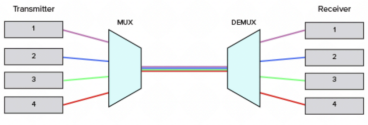


Figure 1b) Wavelength Division Multiplexing/Demultiplexing

PLTW Engineering **Digital Electronics**

Jeide, Matthew 2/6/2025 Period 2

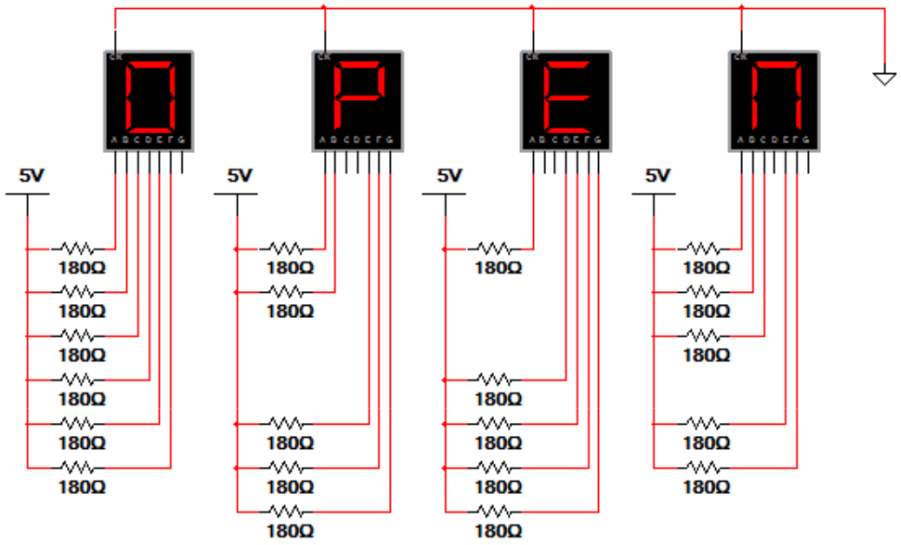
Equipment

Computer with Circuit Design Software (CDS)

Procedure

The schematic diagram shown below is designed to display the word OPEN on four seven-segment displays. Though this design works, it is an inefficient use of power. Each segment draws approximately 18 mAmps from a 5V power supply. It takes 21 segments to display the word OPEN.

Power = Voltage x Current (P=VI), so each segment is using 90 mWatts of power. To display the word OPEN, a total of 90 mWatts x 21 segments = 1.89 watts of power is required. This may not seem like much power, but consider all of the displays that you see every day. If they were all designed using this technique, a tremendous amount of power would be wasted.

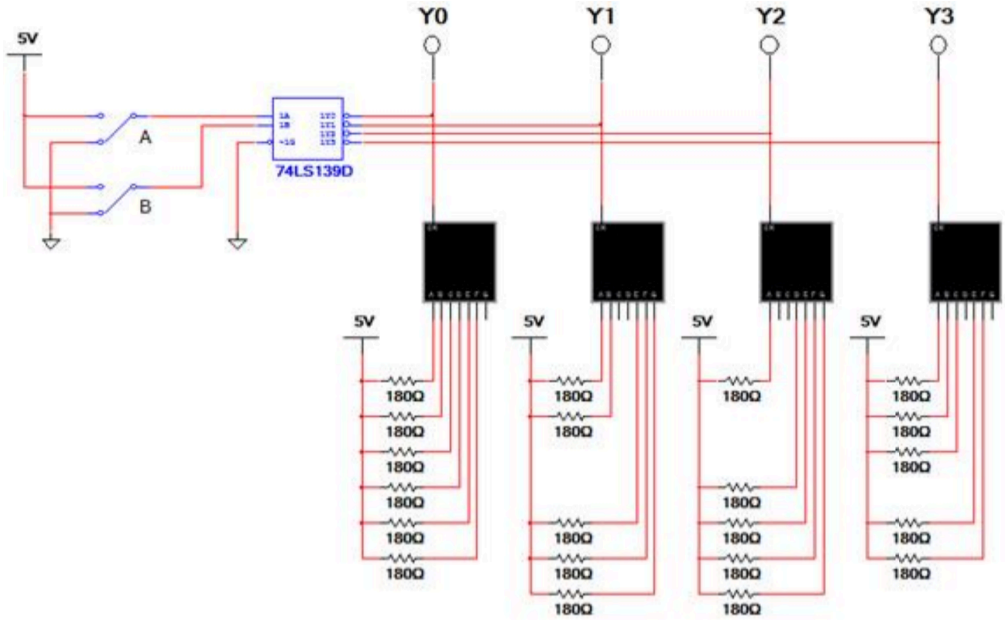


1. Using the CDS, enter this circuit and verify that it is working as expected (that is, is OPEN being displayed?).

Yes.

2. A significantly better way to display the word OPEN is to multiplex the seven-segment displays. Thus, for the word OPEN to be displayed properly, the displays must be de-multiplexed. The schematic diagram below accomplishes this task by using a 74LS139 1-to-4 demultiplexer and two switches. (In a real application, a counter would replace the switches. Counters will be discussed in Unit 3.) In this

implementation, only one display is on at any given time, resulting in significantly reduced power usage.

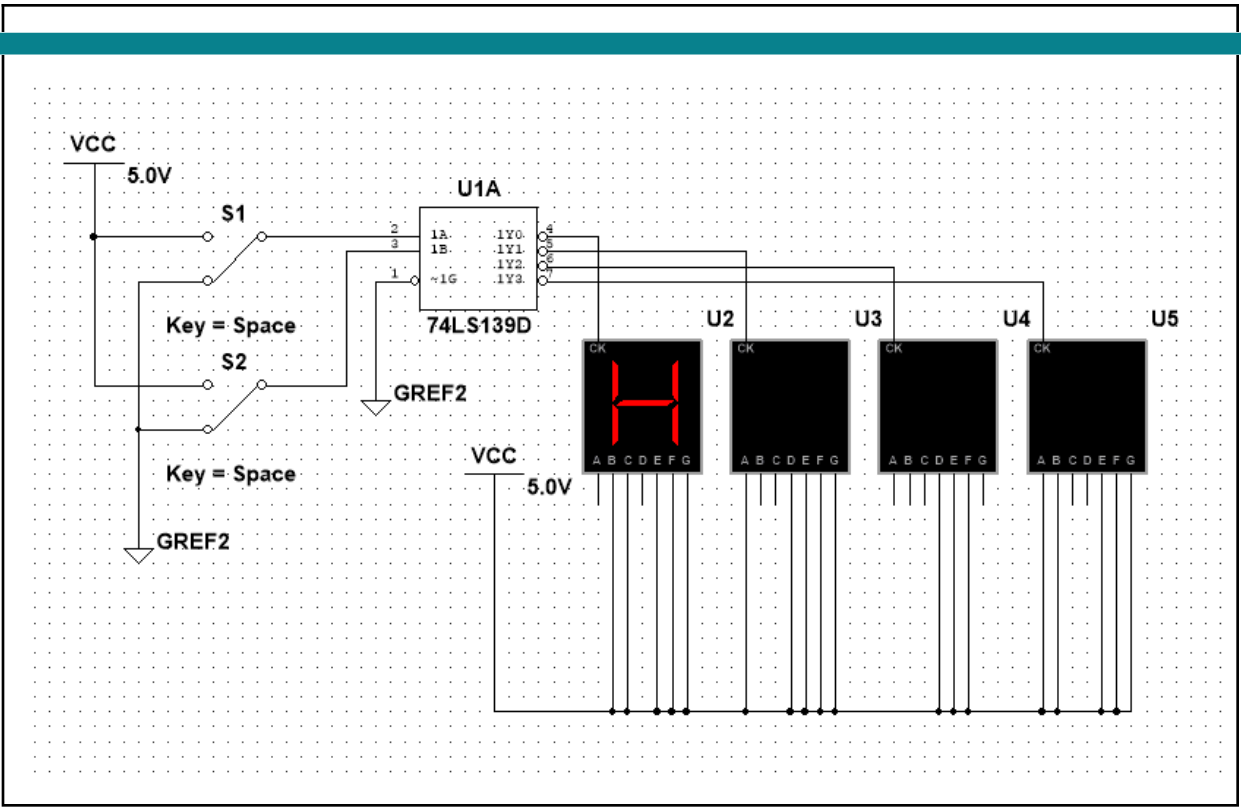


3.Using the CDS, enter this circuit and verify that the circuit is working as expected by completing the table.

B	A	Y0	Y1	Y2	Y3	1st Display	2nd Display	3rd Display	4th Display
0	0	1	0	0	0	ON	OFF	OFF	OFF
0	1	0	1	0	0	OFF	ON	OFF	OFF
1	0	0	0	1	0	OFF	OFF	ON	OFF
1	1	0	0	0	1	OFF	OFF	OFF	ON

4. Use the knowledge you gained from implementing the multiplexed version of the circuit that displayed the word OPEN to design a circuit that displays the word HELP. Print a copy of the circuit and attach to your E-Portfolio.

Insert Multisim Design Here!



5. Using the CDS, enter this circuit and verify that the circuit is working as expected by completing the table. Insert the Multisim video using the Snipping Tool.

B	A	Y0	Y1	Y2	Y3	1st Display	2nd Display	3rd Display	4th Display
0	0	1	0	0	0	ON	OFF	OFF	OFF
0	1	0	1	0	0	OFF	ON	OFF	OFF
1	0	0	0	1	0	OFF	OFF	ON	OFF
1	1	0	0	0	1	OFF	OFF	OFF	ON

Insert Multisim Video Here!. Verbally explain your work.
https://youtu.be/DqPRv8Eov58

Conclusion

Answer in complete sentences each of the questions below.

1. As discussed in the Procedure, the de-multiplexed version of the circuit that displays the word OPEN uses 1.89 watts of power. On average, how much power does the multiplexed version use? For the sake of simplicity, you may assume that the 74LS139 requires no power.

I would assume that if all 4 being on at once used 1.89W and the new system where only one of them is on at a time, the power usage would be decreased by a factor of 4, ~0.4725W.

2. The circuit shown below takes the simplification of the circuit that displays the word OPEN to the next level. This circuit uses the same amount of power as the original multiplexed circuit but requires fewer (and differently-sized ... HINT) resistors. Explain how this circuit works.

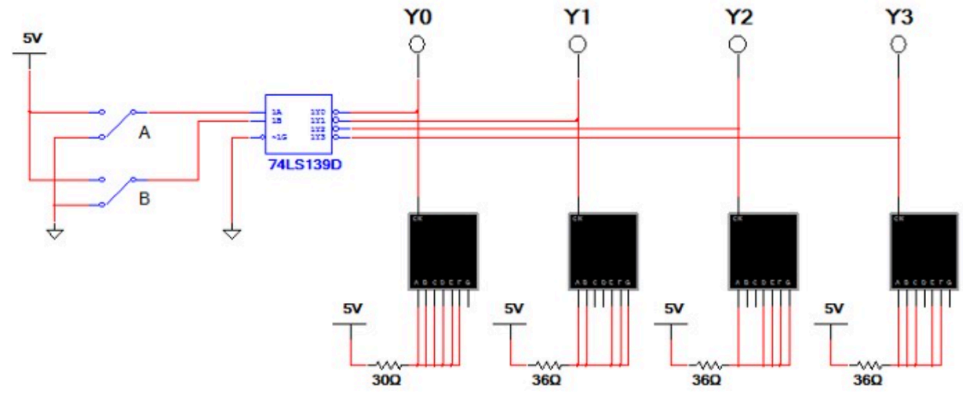


Figure 5. Seven-Segment Displays

Instead of having resistors connected to each LED segment of each seven-segment display, this circuit only uses one resistor per seven-segment display at 30 ohms, instead of 180 ohms. Fewer Ohms means less resistance, meaning more circuit and more power usage.