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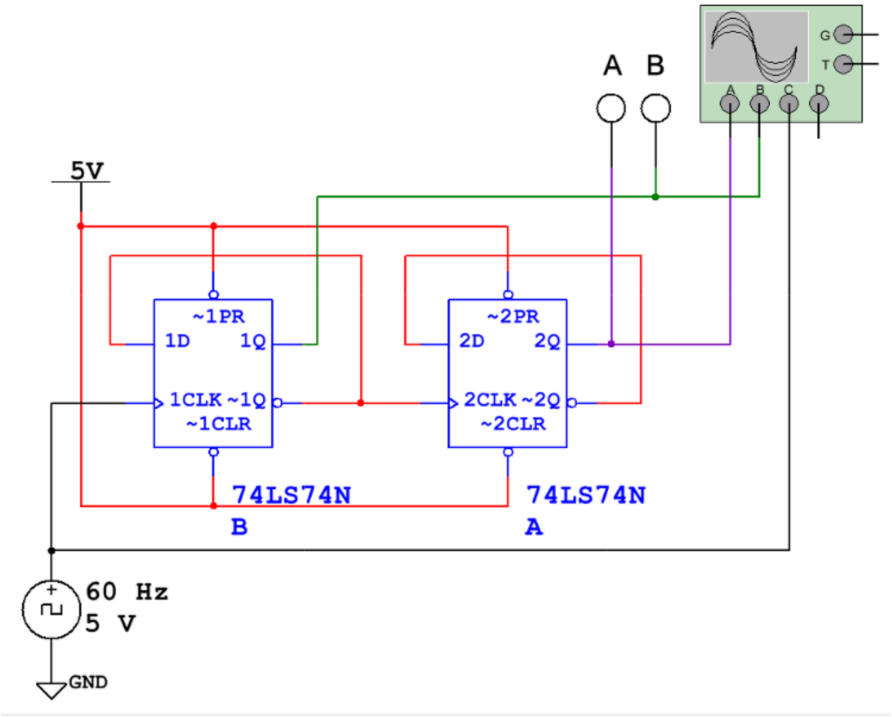
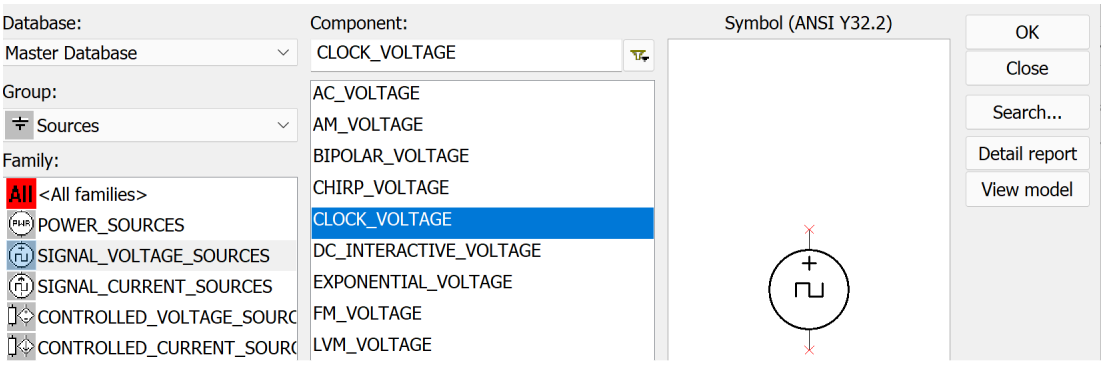
W11: DE 1.2.4 Part 2 Sequential Logic Counters

Read the introduction to Flip-Flops. Must show your work neatly on your Engineering Portfolio. Must show all work. Answer all the questions below after designing the Flip-Flop Sequential Gate in MultiSim.
https://www.loom.com/share/1aff2ce065114b98b58ba4f2b89fbac6?sid=07ce1946-8463-43d6-834d-bc32f09d0ab2

1. Using the CDS, modify the circuit used in step 2 so that it matches Figure 5.



a. The first modification is to replace the switch input with a CLOCK_VOLTAGE. This change will result in the input being continuously toggled. Be sure the CLOCK_VOLTAGE is set to 5 volts, 50% duty cycle, 60 Hz.



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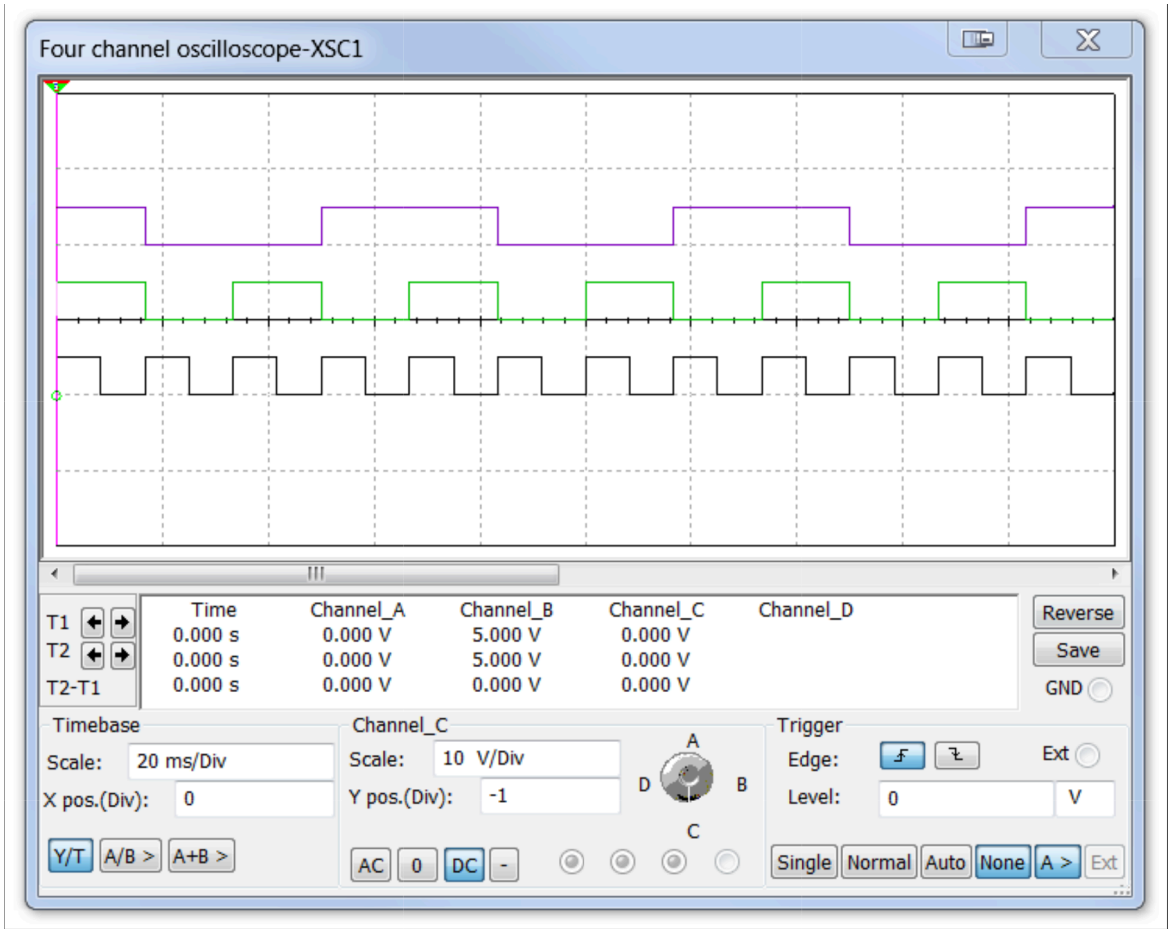
b. The second modification is to add a four-channel oscilloscope that is set up to view the three signals A, B, and Clock-In. [This is found on the right margin.

c. Refer to Figure 6. Be sure to set the oscilloscope's time-base to 20 ms/div and the vertical bases of the four channels to 10 volts/div. Also, adjust the Y position of the three channels such that the three signals are all clearly visible.



d. Start the simulation and let it run until you have captured several periods of each signal.

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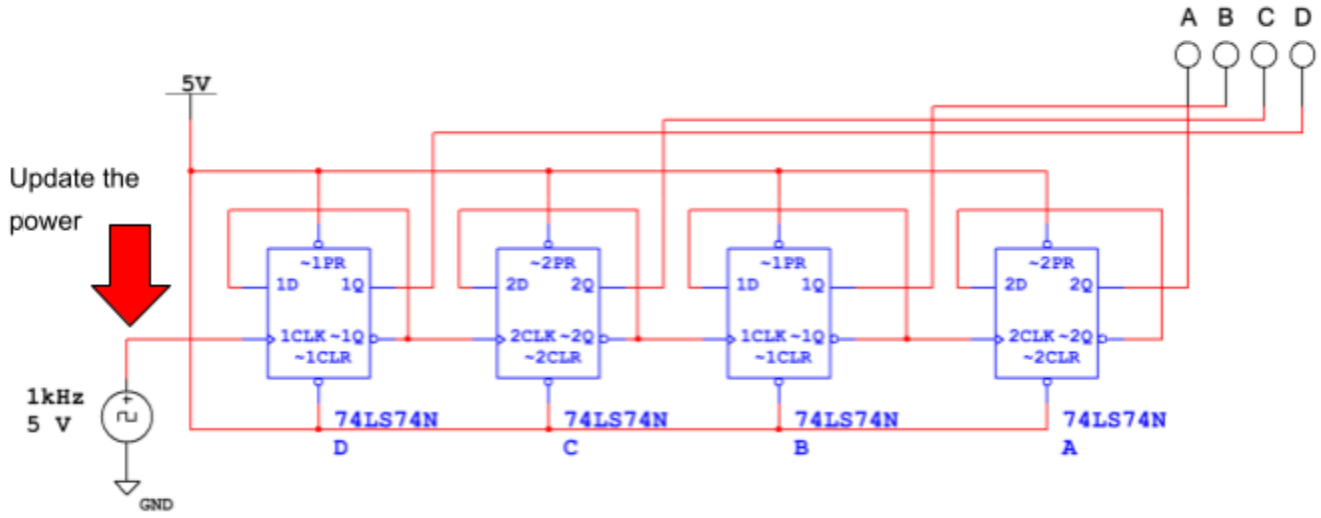
e. Using the oscilloscope's markers, measure the **period of the three signals**. Use this data to **calculate the frequency** for each signal. Record your data in the table with its correct units.

f. Based on these results, explain the relationship of the period and frequency between the three signals. Was this expected?

Signal	Period	Frequency
Clock In	1MS	1000Hz
B	2MS	500Hz
A	4MS	250Hz

2. Analyze the 4-bit binary counter shown in Figure 7 to determine the frequency and period for the signals A, B, C, and D. Use the table to record your answers.



Signal	Period	Frequency
Clock In	1MS	1000Hz
D	16MS	62.5Hz

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C	8MS	125Hz
B	4MS	250Hz
A	2MS	500Hz

With such a fast clock speed (1kHz), it is very difficult to see the binary count. Change the clock frequency to something that allows you to see the four probes transition more slowly in the simulation.

a. Can you count to 15 in binary?
   - Yes.

b. What was the clock frequency that was best for you?
   - 1Hz

Conclusions:

1. The 2-Bit and 4-Bit counters you explored in this activity are referred to as “divide-by-two” counters. Explain the relationship between each consecutive flip-flop and the order in which they are laid out in the design from right to left that creates a binary count.
   a. Each flip-flop divides the previous one’s frequency by two. Laid out right to left, they create a binary count because each bit toggles the next.
2. If you added a fifth bit, what would you guess is the highest number you could count to?
   a. Adding a fifth bit would let you count up to 31 (binary 11111).