University of Utah
Electrical & Computer Engineering Department
ECE 1250 Lab 7
Sequential Digital Logic (Counters)

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Note: Bring textbook & parts used last time to lab.

Objective
To learn about sequential logic by constructing a 2 counters.

Parts to be supplied by the student:
- 2 74LS73 dual JK negative edge-triggered flip-flop ICs (Integrated Circuits)
- 74LS08 quad 2-input AND gate IC (you should already have this)
- 4 270 Ω resistors (Red Violet Brown) (you may already have 3)
- 4 LEDs (Light Emitting Diodes) (you may already have 3)
- Breadboard and wires

Background
Read section 12.6.7 (p693) in your textbook about counters. In this lab you will build the ripple counter shown in Figure 12.89 and the synchronous counter shown in Figure 12.91.

Experiment
Look at the drawings in the Appendix on the last page of this lab and place your ICs, resistors, and LEDs on your breadboard. The positive supply pin of the IC is labeled Vcc and the negative supply is ground. Make the power connections to the ICs. Set the bench power supply to 5 V, turn the output off and connect the supply to your breadboard.

Connect and Test the Ripple Counter
Cut out one of the drawings like the one at the end of this lab (or in a file on the course website) and draw the wires needed to make the ripple counter shown in Fig. 1 below (and Figure 12.89 (p693) in your textbook). Be sure to wire the rightmost LED as the LSB of the output (Q_0) and the left-most LED as the MSB of the output (Q_3). Connect all the CLRs to high. When you are satisfied that your drawing is correct and complete, tape it in your notebook and use it to help you wire the actual circuit.

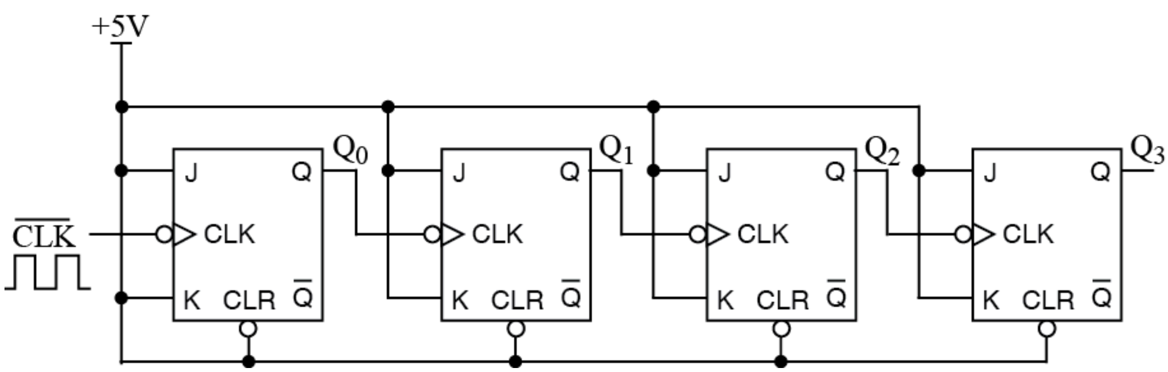

Fig. 1. 4-bit ripple counter.

Turn on the power. The LEDs may come up in a random number, that's OK. Turn on the signal generator, adjust the frequency to 2 Hz, and connect the SYNC output to the clock input of your first flip-flop. (See Fig. 2.) Your counter should start counting as soon as you make the connection. Observe the output LEDs through several cycles of counting. Note what happens when the count passes 15. (If you have trouble getting the counter to work, try building it one flip-flop at a time.)

Turn up the frequency to 16 kHz or so. Hook CH2 of the scope to the input and CH1 to the LSB of the output (Q). Note the relative frequencies. Repeat for all the output bits.

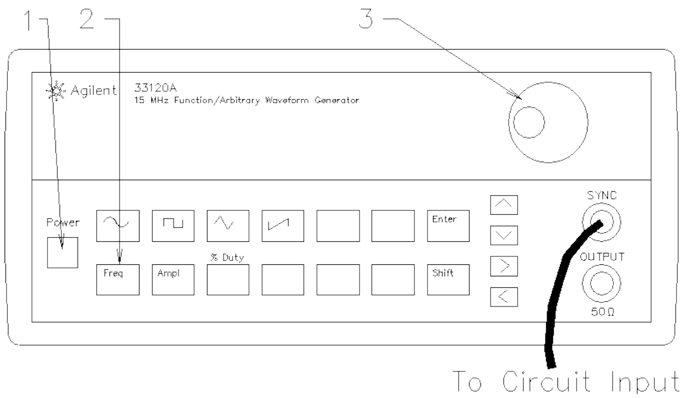

Fig. 2. Using waveform generator synch output for clock signal.

When observing the MSB, turn up the frequency and/or adjust the scope so that you can see and measure the delay from the positive edge of the input to the positive edge of the MSB.

When you are finished with this counter and your notebook, disconnect the signal generator FIRST and then disconnect or turn off the output of the power supply.

Connect and Test the Synchronous Counter

Repeat the above procedure to plan and wire the synchronous counter shown in Fig. 3 and in textbook Figure 12.91.

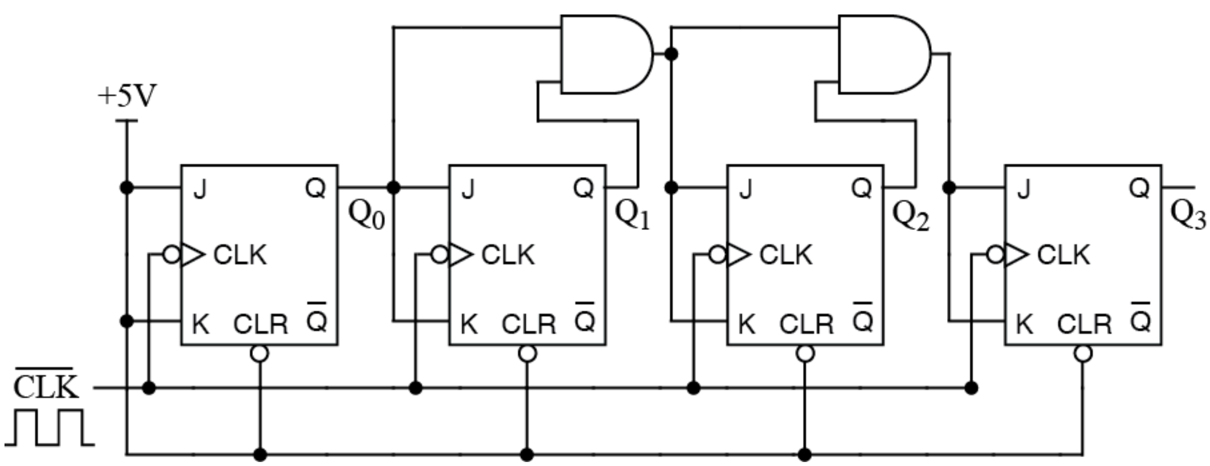

Fig. 3. 4-bit synchronous counter.

Observe the counting at a low frequency to check the operation. Hook up the scope as before to observe the MSB and the input, turn up the frequency and adjust the scope so that you can see and measure the delay from the positive edge of the input to the positive edge of the MSB. It should be significantly less than before, explain why.

When you are finished with this counter and your notebook, disconnect the signal generator FIRST and then disconnect or turn off the output of the power supply.

Conclusion

Check off and conclude as always.

Appendix

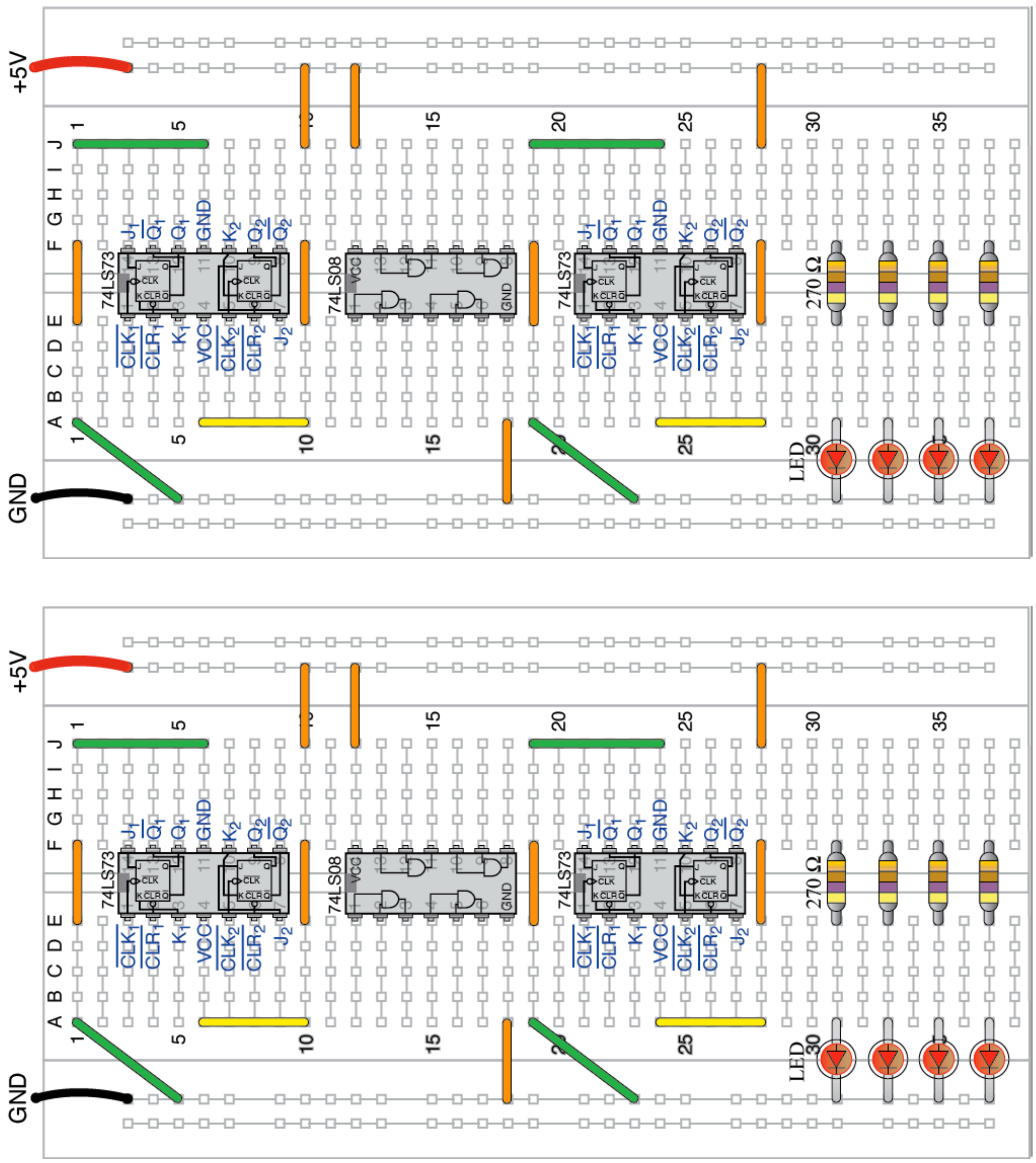

Fig. A1. 4-bit Counter Layout.