

Name \_\_\_\_\_

# EET 1131 Lab #12

## Shift Registers

### Equipment and Components

Safety glasses  
ETS-7000 Digital-Analog Training System  
Integrated Circuits: 74164, 74195  
Quartus II software and Altera DE2-115 board

### Shift Registers

1. The glossary on pages 667-668 of your textbook defines the word **shift register**. Copy this sentence below and make sure you understand what it means.

A **shift register** is

2. Using Texas Instruments' website (<http://www.ti.com>), find the datasheets for the following chips:
  - 74164
  - 74165
  - 74194
  - 74195 (You probably won't find this one at [www.ti.com](http://www.ti.com), but I've uploaded a copy to the course website.)

According to the headings in the upper right-hand corners of the datasheets, what are the functions of these chips?

74164 \_\_\_\_\_

74165 \_\_\_\_\_

74194 \_\_\_\_\_

74195 \_\_\_\_\_ (You probably won't find this one at [www.ti.com](http://www.ti.com), but I've uploaded a copy to the course website.)

## 74164 Shift Register as a Time Delay

1. In the space below, and using a straight edge, copy the 74164's pin diagram and logic symbol from Texas Instruments' datasheet. Be sure to include each pin's name and number. Also be sure to include any markings that indicate active-low inputs or outputs.

74164 pin diagram

74164 logic symbol

2. Use the 74164's logic symbol to answer the following questions:

How many **input** pins does a 74164 have? \_\_\_\_\_

Which one of the following statements is true?

- All of the 74164's inputs are active-high.
- All of the 74164's inputs are active-low.
- Some of the 74164's inputs are active-high, and some are active-low.

How many **output** pins does a 74164 have? \_\_\_\_\_

Which one of the following statements is true?

- All of the 74164's outputs are active-high.
- All of the 74164's outputs are active-low.
- Some of the 74164's outputs are active-high, and some are active-low.

3. Compare your logic symbol above to the textbook's logic symbol in Figure 13-10(a). Notice that the book's symbol uses different names for most of the pins.

In the book's symbol, what is the name for the pin that you named  $Q_A$ ? \_\_\_\_\_

In the book's symbol, what is the name for the pin that you named  $Q_H$ ? \_\_\_\_\_

In the book's symbol, what is the name for the pin that you named  $A$ ? \_\_\_\_\_

Shift registers can be used to introduce a time delay into a digital circuit. The amount of delay time will depend on the number of bits in the shift register and the frequency of its clock signal.

For example, suppose an 8-bit shift register is clocked at a frequency of 2 Hz. What is the clock's period?

\_\_\_\_\_

If you send a signal into one end of this 8-bit shift register and then shift it through the register, how much time will pass between the signal's entry into the register and its exit from the register?

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Let's use a 74164 chip to demonstrate this application. Wire a 74164 chip on the breadboard as follows:

- Connect its  $A$  input to the non-inverted terminal of one of the trainer's pulse switches.
  - Connect the chip's  $Q_H$  output (the rightmost output bit) to an LED.
  - Set the trainer's frequency to about 2 Hz, and then connect the trainer's TTL MODE terminal to the 74164's CLK input.
  - We won't use the 74164's other inputs, but as you know, you should never leave input pins floating. So, based on your understanding of what these pins do and whether they are active-HIGH or active-LOW, tie each one either HIGH or LOW.
4. When your circuit is built, press the pulse switch, hold it down for about 0.5 seconds, and then release it. The LED should blink on and off after the time delay that you predicted above.
  5. Now use the oscilloscope to display the 74164's  $A$  input on Channel 1 and its  $Q_H$  output on Channel 2. Adjust the oscilloscope SECONDS/DIVISION setting until you can see both the input pulse on Channel 1 and the output pulse on Channel 2. Then press the oscilloscope's RUN/STOP button to freeze the display, and use the oscilloscope's cursors to measure the time delay between the rising edges of the input and output pulses. Adjust the trainer's frequency until this time delay is between 3.75 and 4.25 seconds. **Get a printout** of the screen, including your time delay measurement. Label it **Shift Register Time Delay**, and **turn it in** with this lab.
  6. When your circuit works correctly, ask me to check it.

Safety glasses? \_\_\_\_\_ Circuit works? \_\_\_\_\_ DIPs inserted correctly? \_\_\_\_\_

Using power/ground busses? \_\_\_\_\_ Wire colors? \_\_\_\_\_

Wire lengths? \_\_\_\_\_ Wire ends trimmed? \_\_\_\_\_ DIPs accessible? \_\_\_\_\_

## 74195 Shift Register as a Ring Shift Counter

1. In the space below, and using a straight edge, copy the 74195's pin diagram and logic symbol from Texas Instruments' datasheet. (You probably won't find this chip's datasheet on [www.ti.com](http://www.ti.com), but I've uploaded a copy to the course website.) Be sure to include each pin's name and number. Also be sure to include any markings that indicate active-low inputs or outputs.

74195 pin diagram

74195 logic symbol

2. Use the 74195's logic symbol to answer the following questions:

How many **input** pins does a 74195 have? \_\_\_\_\_

Which one of the following statements is true?

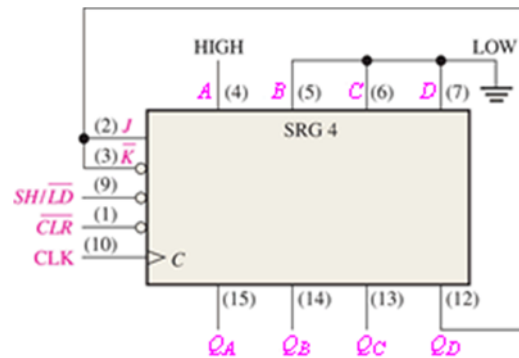
- All of the 74195's inputs are active-high.
- All of the 74195's inputs are active-low.
- Some of the 74195's inputs are active-high, and some are active-low.

How many **output** pins does a 74195 have? \_\_\_\_\_

Which one of the following statements is true?

- All of the 74195's outputs are active-high.
- All of the 74195's outputs are active-low.
- Some of the 74195's outputs are active-high, and some are active-low.

Recall from lecture or from the textbook how a **ring shift counter** behaves. The diagram below shows how to connect a 74195 as a ring shift counter.



3. Create a new Quartus II project named **Lab12ShiftCounter**. Then create a bdf file that contains a 74195 with the connections shown in this diagram. (Quartus II's names for the 74195's inputs and outputs do not exactly match the names used in the diagram above. But you should be able to figure out which pins are which.) Also:
  - Connect Quartus output pins to the 74195's pins named  $Q_A$ ,  $Q_B$ ,  $Q_C$ , and  $Q_D$  above, and give these pins appropriate names.
  - Connect appropriately named Quartus input pins to the 74195's pins named  $SH/\overline{LD}$  and  $\overline{CLR}$  above.
  - To the 74195's pin named  $CLK$ , connect a Quartus input followed by a chain of frequency dividers, as you have done in previous labs when you wanted to reduce the Cyclone chip's 50 MHz clock input down to a frequency of about 3 Hz.
4. Perform analysis and synthesis, and then assign pin numbers as follows:
  - Connect your circuit's  $\overline{CLR}$  input to the DE2-115 board's push button named KEY0.
  - Connect your circuit's  $SH/\overline{LD}$  input to the DE2-115 board's push button named KEY1.
  - Connect your circuit's  $CLK$  input to the Cyclone chip's 50 MHz clock source, as in previous labs.
  - Connect your circuit's output pins to four of the DE2-115 board's LEDs.
5. Compile your design and download it to the Cyclone chip.
6. When your circuit is built, press and release the DE2-115's push button named KEY0 to clear out the shift register. Next, press KEY1 to load a single 1 into the shift register, and then release the push button. The LEDs should show that the 74195 is behaving like a ring shift counter.
7. When your circuit works correctly, ask me to check it. \_\_\_\_\_
8. Next, modify your chain of frequency dividers to increase the clock's frequency from about 3 Hz to about 3 kHz. Use the oscilloscope to display the 74195's four output waveforms, arranged in order on the screen from top to bottom. Adjust the oscilloscope's SEC/DIV control to fit two or three cycles of each waveform on the screen. Use the oscilloscope's **Measure** button to display Channel 1's frequency, period, and pulse width.
9. Ask me to check your circuit. \_\_\_\_\_

10. **Get a printout** of the screen, including your measurements, label it **Ring Shift Counter**, and **turn it in** with this lab.
11. Disconnect the oscilloscope and reduce the clock frequency back to about 3 Hz.
12. Back in Quartus II, expand the circuit from 4 bits to 8 bits by cascading a second 74195 to the original one. (You'll have to think about how to connect the two 74195s to each other.)
13. Assign any new pin numbers needed to display all eight of the ring shift counter's output bits, in order, on eight of the DE2-115's LEDs. Then compile your design and download it to the Cyclone chip.
14. When your circuit works correctly, ask me to check it. \_\_\_\_\_

#### **74195 Shift Register as a Johnson Shift Counter**

1. Recall from lecture or from the textbook how a **Johnson shift counter** behaves. Back in Quartus II, modify the previous circuit to make it an 8-bit Johnson shift counter instead of an 8-bit ring shift counter. (The change required is very minor.)
2. When your circuit works correctly, ask me to check it. \_\_\_\_\_