Activity 3.1.3

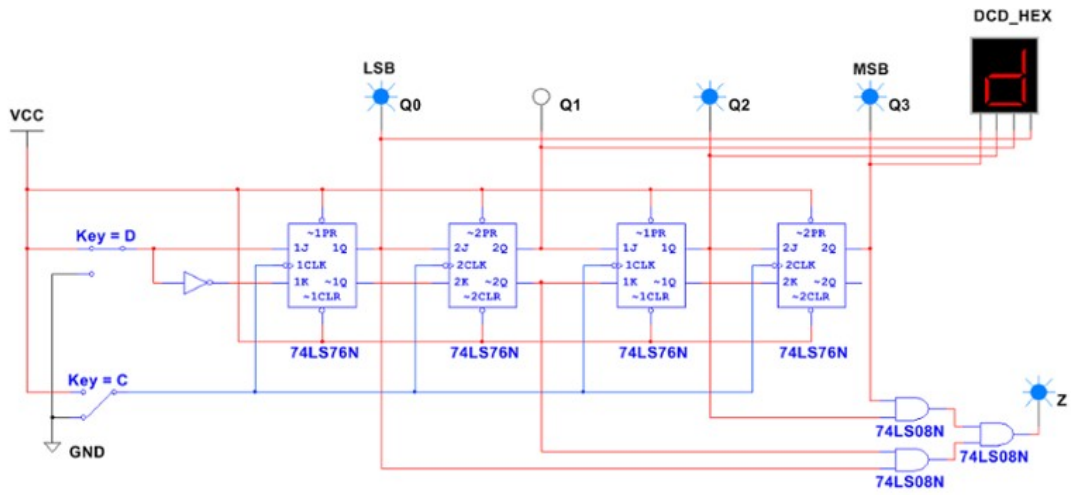
# Flip-Flop Applications: Shift Registers Using PLTW S7

## INTRODUCTION

In the previous activity you simulated an event detector circuit using a phototransistor and a **D flip-flop.** In this activity we will use a **shift register** as an event detector.

In this design, the output is **triggered** only when a specific binary number is entered. You will create a 4-bit shift register and design the event output to trigger on the number:

$1101_2 = 13_{10} = d_{16}$



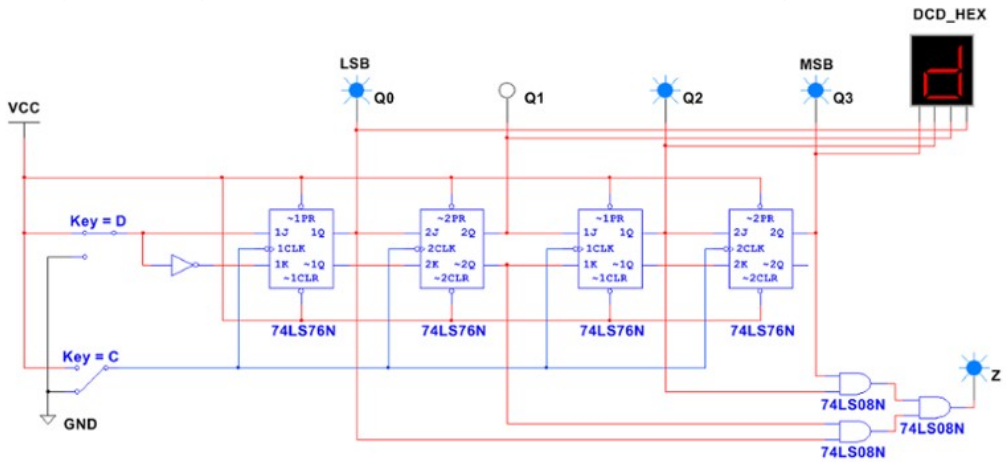
## EQUIPMENT

- Circuit Design Software (CDS)
- Digital MiniSystem (DMS)
- PLTW S7 FPGA Module
- #22-gauge solid wire

# Procedure

## Simulation (Design Mode)

1. Using the Design Mode of the CDS, enter the 4-bit shift register circuit.

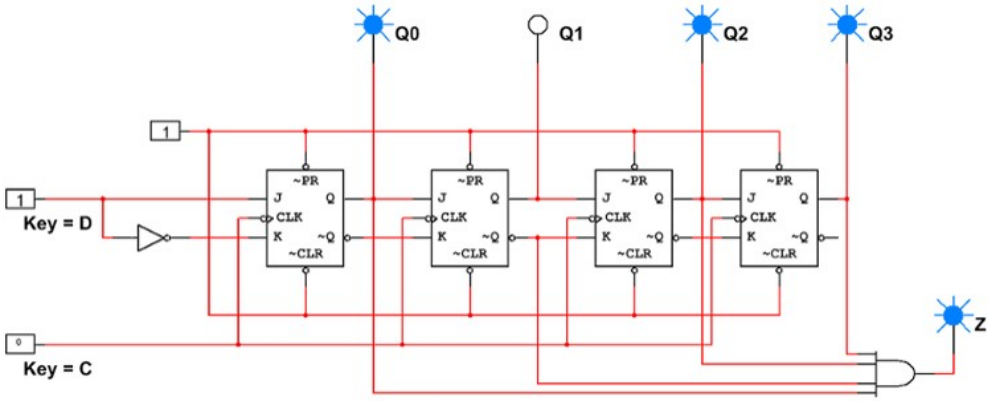



2. Start the simulation and verify that the circuit is working as expected by trying various input sequences and confirming that the sequence 1,1,0,1 is detected while others are not. If the circuit is not working as expected, review your circuit and make necessary corrections.

3. Make the necessary modifications to the circuit so that it will detect the input sequence 0,1,1,0. Simulate this new circuit and verify that it is working as designed. If not, make necessary corrections.

## Simulation (PLD Mode)

4. Using the PLD Mode of the CDS, enter the 4-bit shift register circuit.




5 Start the simulation in PLD Mode and verify that the circuit is working as expected by trying various input sequences and confirming that the sequence 1,1,0,1 is detected while others are not. If the circuit is not working as expected, review your circuit and make necessary corrections.

6 Make the necessary modification to the circuit so that it will detect the input sequence 0,1,1,0. Simulate this new circuit and verify that it is working as designed. If not, make necessary corrections.

## Export to PLD (PLD Mode)

7 Assign the inputs/outputs in PLD Mode and wire the circuit using the DLB or DMS.

a. Assign **Data In** to a Slide Switch.
b. Assign **Clock** to a Push Button.
c. Assign 4 LEDs of the same color in a row. **(D0-D3:DMS)** or **(LD0-LD3: DLB)**
d. Assign **Output Z** to any other LED.

8 Verify the (0,1,1,0) design works on your DMS or DLB.

## CONCLUSION

1. If looking at only the four probes (D0,D1,D2,D3), you might have been confused as to when you see the input number 1,1,0,1 or 0,1,1,0. Why?

Proceed to next lesson