

ECE 380: Lab #9: Flip-Flops and Counters

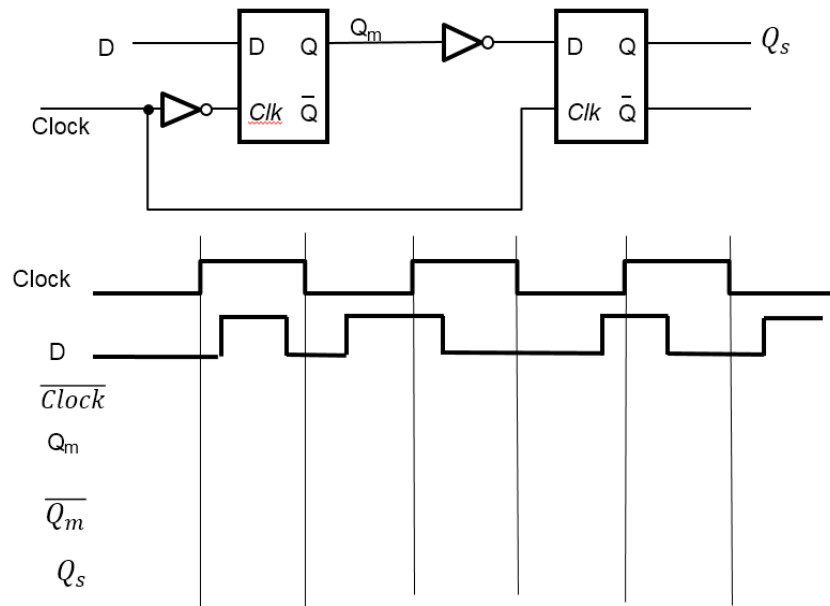
1. Implement Design A-1 and A-2 (for the Cyclone® V device) of the pre-lab. Verify the correctness of the design by simulating it in Quartus using the waveform from Figure 1 of the prelab.
2. Download Design A-1 and A-2 on the Cyclone® V device. Use inputs SW[0] for the input D and KEY[0] for the clock. Use LEDR[0] for the output Q. Test the design for correct functionality.
3. Implement Design B-1 and B-2 (for the Cyclone® V device) of the pre-lab. Verify the correctness of the design by simulating it in Quartus II using the waveform from Figure 2 of the prelab.
4. Download Design B-1 and B-2 on the Cyclone® V device. Use inputs SW[0] for J, SW[1] for K and KEY[0] for the clock. Use LEDR[0] for the output Q. Test the design for correct functionality.
5. Implement Design C-1. Verify the correctness of the design by simulating it in Quartus.
6. Implement Design C-2. Download the **Design C-2** to the DE1 board. Use the following inputs: Pushbuttons KEY0 for **CLEAR**; and toggle switch SW [0] for **ENABLE**.

Use seven digit display HEX0 [6..0] (HEX0 [0] is the MSB and HEX0[6] is the LSB) for the hex [0..6] outputs .

Use PIN_AF14 for the 50 MHz internal clock (see Lab 2 Part II for details).

Homework # 9 (100 points)

Q1 (20 pts): Complete the timing diagram for the following device (Q starts as 0):



Q2 (20 pts): Draw the circuit of a JK flip flop using a D flip-flop. Write down its characteristic table. In what condition, the JK flip flop can be turned into a T flip-flop?

Q3 (30 pts): Synchronous 3-digit counters based on T flip-flops.

- 1) Write down the input logic functions for three T flip-flops for 3-digit synchronous up-counter.
- 2) Write down the input logic functions for three T flip-flops for 3-digit synchronous down-counter.
- 3) Draw the schematic of a synchronous 3-digit up/down counter, which can count either upward or downward, controlled by a control signal up/down.

Q4 (30 pts): Synchronous two-digit BCD counter, with the two four-bit up-counters with synchronous loading function as shown below. Draw the circuit that counts from 0 to 65.

