

Lab 5 – Counter with External Input

CS 2052 Computer Architecture

Dept. of Computer Science and Engineering, University of Moratuwa

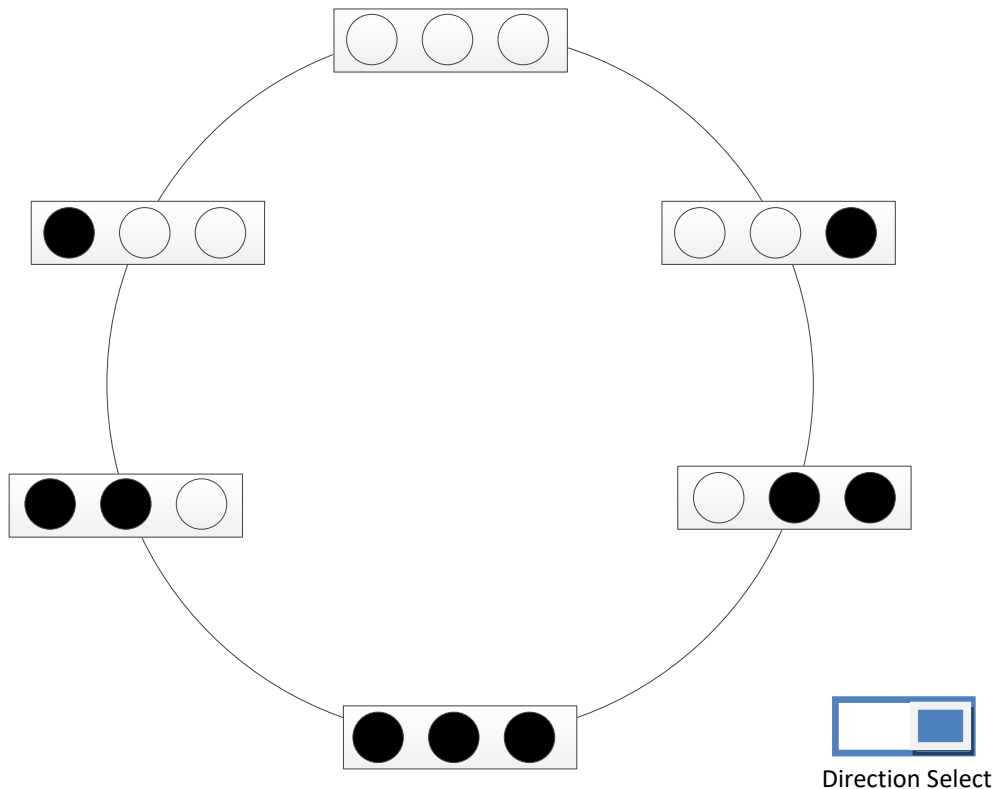
Learning Outcomes

In this lab, we will design a 3-bit counter with external input. After completing the lab, you will be able to:

- design and develop a 3-bit counter
- count in clockwise and anticlockwise directions based on an external input
- verify its functionality via simulation and on the development board

Introduction

A register that goes through a predetermined sequence of states is called a counter. In this lab, we will design a 3-bit counter that can show the following sequence of LEDs (dark circles indicate LEDs that are lit). We will control the direction of counting (clockwise or anticlockwise) based on an external input. When the input button is switched off, we will count in the clockwise direction. When it is switched on, we will count in the anticlockwise direction.



Building the Circuits

Step 1: Using the Excitation Table of a D Flip Flop complete the following table.

Q_t			Button	Q_{t+1}			D_2	D_1	D_0
Q_2	Q_1	Q_0		Q_2	Q_1	Q_0			
0	0	0	0	0	0	1			
0	0	0	1	1	0	0			
0	0	1	0	0	1	1			
0	0	1	1	0	0	0			
...			
...			

Identify the inputs to D Flip Flops D_0 , D_1 , and D_2 . Use Karnaugh Maps to simplify the expressions. Interpret the combinations that will not occur as don't care.

Step 2: Building 3-bit bit counter.

Build the 3-bit counter using D Flip Flops and other basic logic gates.

Step 3: Connecting inputs and outputs.

Connect switch **SW0** as the external input and **BTNO** as the Clock input. Connect outputs **Q0 - Q2** to LEDs **LD0 - LD2**.

Verify the functionality of your counter using the simulator.

Step 4: Test on BASYS2.

Generate the programming file (i.e., bitstream) and load it to the BASYS2 board.

Change the switches on the BASYS2 and verify the functionality of your circuit.

Demonstrate the circuit to the instructor and get the Lab Completion Log signed.

Step 5: Lab Report

You need to submit a report for this lab. Your report should include the following:

- Student name, index number, and group
- Do not attach a separate front page
- State the assigned lab task in a few sentences
- Completed table in Step 1.
- Simplified expressions for D_0 , D_1 , and D_2 using Karnaugh Maps
- Schematic circuit
- Timing diagram
- Discuss suitability of using a push button as the clock signal.
- Conclusions from the lab.

Submit the lab report at the beginning of the next lab.

Prepared By

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- Updated on Sep 21, 2017