Lab 8: Flip Flops

Introduction

A flip-flop is something that stores bits on the clock edge as opposed to the level. That is, edges are triggered—they respond to input only during transition from 1 to 0 or 0 to 1. An example would be a light switch. The light only turns on when you flip the switch up (active high). Nothing else happens within this state. When the light switch is switched down, then the light turns off. Therefore, this change in the control input determines the state of flip-flops. The figure below shows the different behavior latches and flip-flops can have. In the most trivial case, we want to account for positive and negative edge responses.

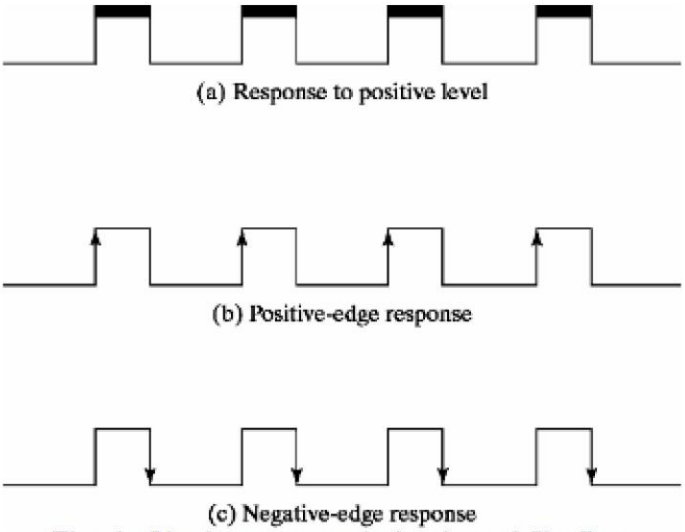

Fig. 1: Clock response in latch and flip-flop.

Flip-flops account for the inability of latches to properly store information. The issue of latches and storing information arises from the clock pulses and current state of the circuit. The problem is that latches respond to a change in the level of a clock pulse. The key to the proper operation of a flip-flop is to trigger it only during a signal transition. One way to fix this is to use two latches in a special configuration that isolates the output of the flip-flop and prevents it from being affected while the input to the flip-flop is changing. For example, in a D flip flop, two latches are employed. The first latch acts as the master where the second one acts as the slave. The output of the master D latch becomes the input of the slave. The output of the slave D latch becomes the output we want. An example of this is shown in Figure 2.

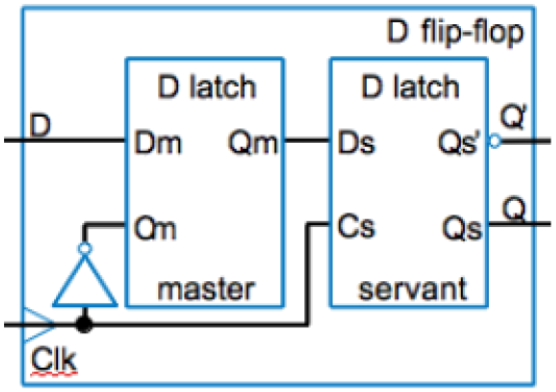

Fig. 2: Master-slave D flip-flop

In summary, D flip-flops are comprised of two D latches: master and slave. D flip-flops require input, a clock, and produces output according to state transitions (positive or negative edge transitions). Lastly, flip-flops are typically combined with an external combinational circuit to store outputs from that circuit. Large-scale integration circuits contain thousands of gates within one package. These circuits are constructed by interconnecting the various gates the provide a digital system. Flip-flops are basically constructed from these interconnection of gates.

Objectives

Students will be introduced to latches and flip-flops. In particular, students will cover the depth of D flip-flops. Additionally, students will learn about state, transitions, and clocks with respect to a circuit.

[100 points] Procedure & Results

Integration of external circuits with D flip-flops

Consider the flight attendant call button discusses in the lecture. The idea is to turn on a light when the call button is pressed and turn it off when the cancel button is pressed.

Include the following in your lab report:

1- Truth table.

2-"Sum of minterms" logical expression. Karnaugh maps.

3-Simplified logical expression.

4-In Logisim, high-level design using the D flip-flop block diagram and additional logic gates

5-Implement on breadboard using 7474 (D flip-flop), 7404 (INVERTER), 7408 (AND),and 7432