Lab 6: Debouncing Switches

Introduction

A switch is a mechanical device and as such is much slower than an electronic circuit. When a switch is opened or closed the mechanical contacts do not break or make a connection instantaneously, but can "bounce" between open and closed, thus making several transitions. If one were to use a mechanical switch to increment a counter (to count, say, people going through a turnstile), a single closure of the switch could increment the counter many times. In this lab use the logic analyzer to look at switch bounce, and use an SR latch to debounce a mechanical switch.
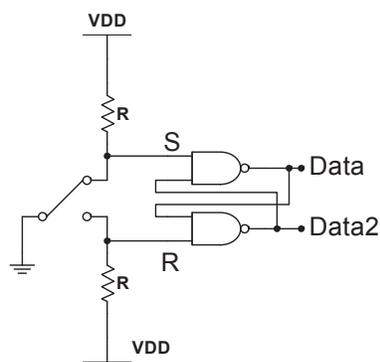
1   Prelab

Figure 1: NAND Debounced Single-Pole Double-Throw (SPDT) Switch Circuit

1.1. The waveform shown in Figure 2 shows the values on S and R when the switch of Figure 1 is moved from the UP position to the Down position, then moved back to the UP position. Complete the timing diagram to show the expected values of Data (Top **NAND** gate; takes S as an input) and Data2 (Bottom **NAND** gate; takes R as an input) outputs.
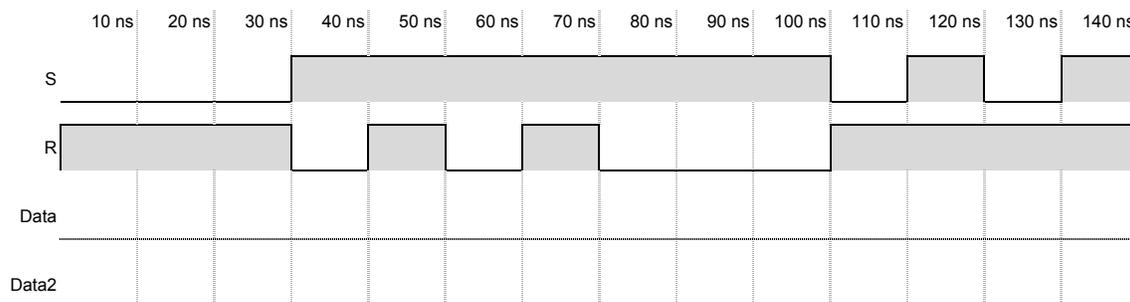

Figure 2: SR Latch Sample Input for Prelab

2   Lab

2.1   Switch Bounce

2.1.1. Build the switch in Figure 3. For now, just use a wire as the switch. Plug the wire into GND to bring DATA (the switch output) low, alternatively, unplug it to bring DATA high.
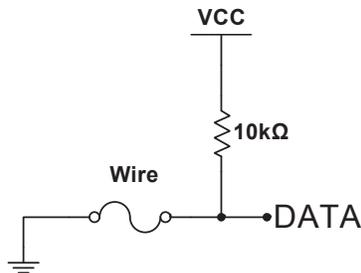

Figure 3: Simple Switch Circuit

2.1.2. Test the circuit with a logic probe and make sure it works as described above.

2.1.3. Connect the output of the switch to one channel of your logic analyzer. Set up the logic analyzer for a 5 MHz internal clock. Start with your switch closed (wire in the GND hole). Click on the play button, pull the wire out, and see if you can observe switch bounce.

2.1.4. You couldn't see the switch bounce in the above part because the logic analyzer is much faster than you are. By the time you pulled out the wire after you started sampling, the analyzer had already finished sampling, so you were not able to observe the low-to-high transition of the switch. In order to observe this transition you need to have the logic analyzer stop shortly after this transition. Making the logic analyzer stop after observing a desired pattern is called triggering. To trigger the logic analyzer on the low-to-high transition of your switch, do the following:

- Click on the "Trig" icon, click on the channel you are going to use and select "1" to capture the input on whenever your channel is 1. After the line goes high, it will sample for a while longer; then show the logic trace both before and after the trigger condition.
- Then click the "ok" button, and you are ready to start sampling.

2.1.5. Pull the wire out of the GND hole. The logic analyzer should stop, and display the switch bouncing.

2.1.6. Capture the waveform for several switch bounces.

2.1.7. **How many bounces do you typically get?**

2.1.8. **What is the typical length of a bounce?**

2.1.9. **From the initial low-to-high transition, how long does it take the switch to reach a constant high value?**

2.1.10. Repeat with the switch initially in the open position.

2.2 Debouncing with an SR Latch

2.2.1. Build the circuit shown in Figure 1. Use 10kΩ resistors. Use a wire to simulate your switch.

2.2.2. Connect S, R, Data (Q,) and Data2 (Q') to the logic analyzer.

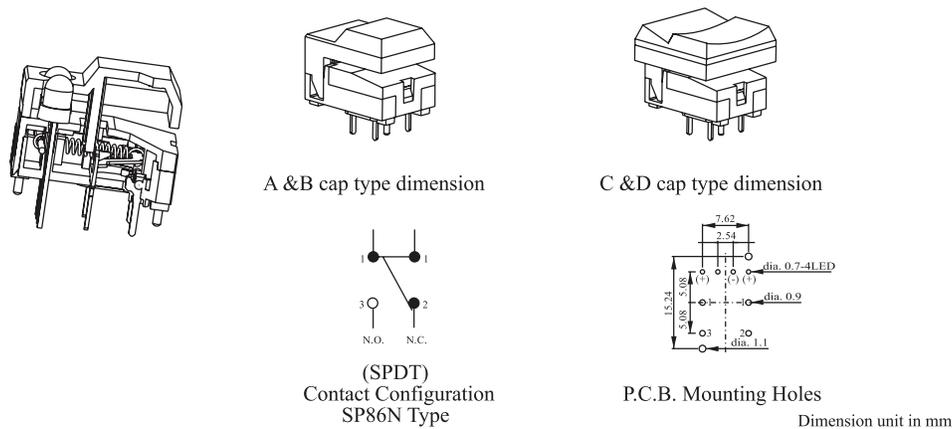2.2.3. Observe the outputs when you toggle your switch.

2.2.4. **Does this circuit eliminate the bouncing?**

2.3 Build a Real Debounced Switch

2.3.1. The switch you are using is a single-pole double-throw switch (shown in Figure 4.) When your switch is oriented with the hinge on the top:

- The common leads will be the two on top.
- Undepressed (unpressed,) the closed lead is the on the right, and the normally open lead is on the left.
- With this information you should be able to build a debounced switch by substituting your single-pole double-throw switch for the wire, in the previous circuit.

2.3.2. Again, observe your circuit using the logic analyzer.

A &B cap type dimension   C &D cap type dimension

(SPDT)
Contact Configuration
SP86N Type

P.C.B. Mounting Holes
Dimension unit in mm

http://www.cresttech.com.au/pdf/switches/SP86N.pdf

Figure 4: Excerpt from SP86N Series Datasheet